DOCUMENT RESUME

ED 131 243 CE 008 336

AUTHOR Stone, C. Harold
TITLE Evaluation of the Marine Corps Task Analysis Program. Final Report. Technical Report No. 16.
INSTITUTION California State Univ., Los Angeles.
SPONS AGENCY Marine Corps, Washington, D.C.; Office of Naval Research, Arlington, Va. Personnel and Training Research Programs Office.
PUB DATE Jun 76
CONTRACT N00014-74-A-0436-0001; NR-151-370
NOTE 83p.

EDRS PRICE MF-$0.83 HC-$4.67 Plus Postage.
DESCRIPTORS Cluster Analysis; Data Analysis; Efficiency; Individual Characteristics; Institutional Research; *Manpower Utilization; *Military Personnel; Military Training; Occupational Information; *Organizational Effectiveness; Performance Criteria; Program Development; *Program Evaluation; Staff Orientation; *Task Analysis; Teamwork
IDENTIFIERS CODAP; Comprehensive Occupational Data Analysis Programs; Marine Corps

ABSTRACT

The basic objective of this research project was to determine the effectiveness of the Marine Corps Task Analysis Program (TA) as it had been conducted by the Office of Manpower Utilization (OMU). Main findings and conclusions are summarized in the eight research areas into which the study was divided: TA observation and interview procedures; task inventory construction; occupational field sample size; computer procedures and data analysis; OMU organization and personnel; orientation, training, and team performance; peace-time task analysis and its relation to war-time conditions; and the use of worker characteristics in classification and assignment. The overall conclusion from the research is that the TA program is a highly valuable asset to the Marine Corps in improving and maintaining effective utilization of its human resources. Appendix A contains an annotated list of 15 technical reports that are end-products of this project, and which contain detailed documentation of all phases of this project. Appendix B contains the study directive used and a distribution list. (Author/TA)

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EVALUATION OF THE MARINE CORPS TASK ANALYSIS PROGRAM

FINAL REPORT

C. Harold Stone
Principal Investigator

Technical Report No. 16

A Research Project Supported By
Commandant of the Marine Corps (Code RD)
And Monitored By
Personnel and Training Research Programs
Psychological Sciences Division
Office of Naval Research
Contract No. N00014-74-A-0436-0001
NR 151-370

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California State University, Los Angeles

June 1976

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report No. 16	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Evaluation of the Marine Corps Task Analysis Program, Final Report		5. TYPE OF REPORT & PERIOD COVERED Final Report May 15, 1974 - March 31, 1976
		6. PERFORMING ORG. REPORT NUMBER Technical Report No. 16
7. AUTHOR(s) C. Harold Stone		8. CONTRACT OR GRANT NUMBER(s) N00014-74-A-0436-0001
9. PERFORMING ORGANIZATION NAME AND ADDRESS California State University, Los Angeles Foundation 5151 State University Drive Los Angeles, Calif. 90032		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS PE 61153N, Proj. RR 042-04 TA RR 042-04-02 NR 151-370
11. CONTROLLING OFFICE NAME AND ADDRESS Personnel and Training Research Programs Office of Naval Research (Code 458) Arlington, Virginia		12. REPORT DATE June, 1976
		13. NUMBER OF PAGES 73
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

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17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This research was sponsored jointly by the Commandant of the Marine Corps (Code RD) and the Office of Naval Research.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Task Analysis	CODAP
Observation & Interview	Cluster Analysis
Task Inventory Construction	Orientation & Training
Sample Size	War-Time Task Analysis
	Worker Characteristics

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The basic objective of this research project was to determine the effectiveness of the Marine Corps Task Analysis Program (TA) as it has been conducted by the Office of Manpower Utilization, Headquarters U.S. Marine Corps (OMU). This report summarizes the main findings and conclusions in the eight Research Areas into which the study was divided: 1. TA Observation and Interview Procedures; 2. Task Inventory Construction; 3. Occupational Field Sample Size; 4. Computer Procedures and Data Analysis; 5. OMU Organization and

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S/N 0102-LF-014-6601

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Personnel; 6. Orientation, Training and Team Performance; 7. Peace-Time TA and Its Relation to War-Time Conditions; and 8. The Use of Worker Characteristics in Classification and Assignment. The over-all conclusion from our research is that the TA Program is a highly valuable asset to the Marine Corps in improving and maintaining effective utilization of its human resources. An Appendix to this Final Report contains an annotated list of the 15 Technical Reports that are end-products of this project.

EXECUTIVE SUMMARY

This is the Final Report of a research project designed to evaluate the Marine Corps Task Analysis (TA) Program. Marine Corps TA studies are conducted by the Office of Manpower Utilization (OMU), Headquarters United States Marine Corps (HQMC). The research was authorized by the Marine Corps Study Directive included as Appendix B to this report. It was funded by the Marine Corps, monitored by the Director, Personnel and Training Research Programs of the Office of Naval Research, and conducted by the California State University, Los Angeles. Marine Corps supervision was provided by the HQMC Study Advisory Committee for Evaluation of the Marine Corps Task Analysis Program.

Task Analysis is the identification, collection, collation and analysis of job data. In the Marine Corps TA Program these data represent responses from Marine job incumbents to a comprehensive set of questions aimed at determining: (1) What the Marine really does; (2) Why the Marine does it; (3) How the Marine does it; (4) At what skill level (learner, worker, first-line supervisor or staff supervisor) the Marine performs. The process of TA in the Marine Corps involves the use of military analysts who prepare a paper and pencil inventory based upon observation and interview and the input of experts; on-site administration of the inventory by OMU members; and analysis on a percentage of time basis at the task level, by processing through the Comprehensive Data Analysis Programs (CODAP). The major goal of the Marine Corps TA program is to improve manpower utilization.

The basic objective of this research project was to determine the efficacy of the TA process as it has been performed by OMU. It was designed to identify and define promising improvements and refinements in the TA process, and to discover possibly superior alternative procdures that could be implemented to produce an even more effective program than that conducted by the Marine Corps for some five years, from late 1969 through mid-1974 when this research commenced.

Based upon our initial Study Plan, the Study Advisory Committee recommended that the project be divided into the following eight Research Areas:

1. Task Analysis Observation and Interview Procedures
2. Task Inventory Construction
3. Occupational Field Sample Size
4. Computer Procedures and Data Analysis
5. OMU Organization and Personnel
6. Orientation, Training, and Team Performance
7. Peace-Time Task Analysis and Its Relation to War-Time Conditions
8. The Use of Worker Characteristics in Classification and Assignment

Methodologies employed were many and varied. They are described in this report and in a series of Technical Reports. In the interest of brevity, they are not included in this Executive Summary.

The over-all conclusion from our research is that the Marine Corps Task Analysis Program is a highly valuable asset to the Marine Corps in improving and maintaining effective utilization of its human resources. OMU, in spite of its austere budget and limited staff, has produced a high return on the investment that the Marine Corps has made in the Program. Important "pay-offs", with Corps-wide impact, include substantial cost savings and cost avoidance, more efficient structuring of Occupational Fields (OF's), more effective use of training resources, and improved morale of Marines in the OF's in which TA studies have been made.

Detailed conclusions and recommendations from the several research areas in this project are included in the fifteen Technical Reports that are end-products of our studies. Many of the conclusions are summarized in the body of this report. Recommendations for improvements in the TA process and for further research to be undertaken by OMU are listed in Section IV.

Several representative findings from our research have been selected for inclusion in this Summary. They are cited in the following paragraphs.

The best method for obtaining accurate and complete data for building a task inventory appears to be: (1) thorough review of all available background data in written materials describing duties in an OF, supplemented by interviews with "experts", (2) preparing preliminary task statements based upon this information, and (3) conducting observation and interview visits to field installations to validate or correct these items and to search out tasks not revealed in preliminary reviews.

Accurate wording of task statements and evaluating their readability to verify that they are written at the easiest reading level possible is necessary to ensure understanding by Marine respondents of instructions and task statements in task inventories.

The size of samples of Marines in a number of OF's studied by OMU has been larger than statistical standards suggest may be needed to obtain representative data about what Marines do. Guidelines for sampling and for further research by OMU are given in Technical Report No. 11

Administration of task inventories to Marines at overseas bases may not be necessary. We have recommended procedures for studies by OMU to determine whether or not our findings are confirmed in other OF's not included in our analyses.

Inclusion of military or "general" duty tasks together with occupational tasks specific to an OF in the analysis of task inventory data can

adversely effect results of the CODAP clustering procedures that identify jobs. Recommendations have been made for further research by OMU to clarify this finding.

We have concluded that the Marine Corps TA Program is essentially a research process. As a result, Technical Report No. 4, "Guidelines for Research Planning and Design in Marine Corps Task Analysis" was written as an aid to OMU in its research activities.

The CODAP programs appear to be the most adequate set of computer procedures for analyzing TA data. However, more programs in the CODAP "package" need to be adapted from the UNIVAC format to the computer facilities available to OMU.

The organizational structure of OMU, traditionally based upon an "independent TA team" concept, needs to be modified to a more functional type of organization. This change should provide for more flexibility, improved communications, greater efficiency, and for specialization in several technical areas.

More formalized training of OMU staff members is needed -- especially for Marines newly assigned to the TA program. Our staff has prepared five Training Manuals to aid OMU in accomplishing this objective.

The task inventory approach appears to be the most feasible and economical means for identifying those tasks that are performed by Marines in combat but that may not be performed under peace-time conditions. Recommendations are given for additional research that is considered needed on this important topic.

Stronger support needs to be provided by HQMC to its personnel research effort. This is considered essential in order to develop and maintain effective selection and placement procedures that can identify recruits who meet Marine Corps standards and those needed to meet requirements in high technology OF's.

HQMC has maintained excellent standards for selection of well qualified Officers for assignment to OMU. On the other hand, the assignment of high quality SNCOs to OMU appears to be more a matter of chance than design.

Broader use of worker characteristics data could be made by the Marine Corps to improve classification and assignment. This is considered especially important in evaluating physical demands and environmental conditions in relation to placement of Women Marines. Specific procedures for implementing recommendations in this report are described in the Technical Report for this Research Area.

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California State University, Los Angeles Foundation

June, 1976

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I

INTRODUCTION

This is the Final Report of the research project, Evaluation of the Marine Corps Task Analysis Program, conducted by the ONR-USMC Research Staff at California State University, Los Angeles. The research project was jointly sponsored by the Commandant of the Marine Corps (Code RD) and the Office of Naval Research. The Marine Corps funded the research and provided special technical support to the Cal State L.A. project staff through the Office of Manpower Utilization, HQMC (OMU). The Personnel and Training Research Programs, Psychological Sciences Division, Office of Naval Research monitored the research and ONR was the official government contracting agency. Dr. Marshall J. Farr, Director of ONR's Personnel and Training Research Programs, served as Scientific Officer. The California State University, Los Angeles Foundation monitored the research for the University and provided logistic support.

The original contract period for the project was from 15 May, 1974 to 30 June, 1975. Several circumstances intervened, however, that created the necessity for extension of the contract period to 31 March, 1976.

In addition to monitoring of the project by ONR, the Commandant of the Marine Corps established a Study Advisory Committee for Evaluation of the Marine Corps Task Analysis Program in mid-1974. The Study Advisory Committee informed our staff that a formal Study Plan for the project was required in order to define research areas more specifically than the descriptions contained in the original research proposal. That Study Plan was submitted in August, 1974.

In an official letter dated 15 October, 1974 the Study Advisory Committee requested that the Study Plan be revised and restructured in accordance with a specified format. In addition, three of the nine Research Areas proposed by the research staff were considered by the Advisory Committee to be either of limited interest or involved problems that could be addressed by OMU. These were dropped from our Study Plan. Two new Research Areas were requested by the Study Advisory Committee to be considered by our research staff, and these were added to our research tasks. The Revised Study Plan was submitted on 31 October, 1974. We were informed of approval of the Study Plan by a letter from the Assistant Deputy Chief of Staff, RD&S, HQMC, dated 25 November, 1974.

The revised Study Plan for this project listed specific research tasks for each of the eight Research Areas. As the study progressed, a few research tasks were found to be impractical in some Areas, either due to technical or other problems. Data assumed to be available for a task in one Research Area, for example, could not be obtained because of security classifications. However, the majority of research tasks proposed

in the Study Plan have been completed. Several additional research tasks were identified in the course of our study that had not been anticipated and were therefore not listed in the Study Plan. Our research staff decided to add these to our original proposals in the belief that these additional studies could be of value to CMU in its Task Analysis studies. These additions have resulted in a greater number of end-products in the form of Technical Reports than we had anticipated in our original estimate of one final report supplemented by two or three technical reports.

As a result of division of this project into eight Research Areas, this Final Report follows a somewhat different pattern than that prescribed for projects addressing a single problem or issue. Specific objectives, methodologies, discussions, conclusions, and descriptions of end-products in this report are summarized under each Research Area for convenience of reference.

It is important to emphasize that this is a summary report and not a detailed documentation of all phases of the project. Details are included in the series of fifteen Technical Reports that are the true end-products of this research. It would be redundant to repeat those details here. However, this report is designed to provide a brief overview of the major aspects of project research efforts.

II

STATEMENT OF THE BACKGROUND AND OVER-ALL STUDY OBJECTIVE

A. The Marine Corps Task Analysis Program

The Marine Corps Task Analysis Program was started in late 1969. It was established to develop and apply a system for continuous, and comprehensive review, analysis, and evaluation of work performed by Marines throughout the Marine Corps. The general purpose of the program is to improve manpower utilization through acquisition and analysis of job related data. The principal methods used to acquire these data are observation, interview, and administration of a task inventory.

The Task Analysis (TA) program methodology has traditionally followed a seven step procedure for each Occupational Field (OF) under study. However, during the latter portion of our study period OMU decided to describe its methodology as a five stage process. The five stages are: 1. Construct a task inventory, 2. Administer self report inventory, 3. Analyze, using CODAP, 4. Recommend solutions to identified problems, 5. Secure approval of recommendations.

The first three phases of the seven step procedure are encompassed by steps one of OMU's present categorization of the TA process. The basic nature and sequence of activities remain essentially the same under both descriptions of the process except for a few minor modifications. Inasmuch as our research was conducted on the seven step process, the majority of our Technical Reports describe the methodology in this manner, and the content of both methods of description are basically the same, we have chosen to follow the seven phase categorization in this Final Report. A brief description of the seven steps is given below:

1. Study Phase. Each Task Analysis review is initiated by an extensive study of information about the OF being analyzed. The information is gathered from many sources.

2. Observation & Interview Phase. During this phase knowledge gained from the study phase is augmented by observing and interviewing Marines in the actual performance of their jobs.

3. Task Inventory Construction Phase. The task inventory is a questionnaire covering tasks at all levels of proficiency as well as questions about incumbent experience and training.

4. Inventory Administration Phase. Inventories developed in Phase 3 are taken to Marine Commands and administered to as large a representative sample of personnel in the OF as possible in order to ensure collection of comprehensive, realistic job data for Marines in each MOS and each pay grade.

5. Processing Phase. Completed inventory response booklets are delivered to Data Processing for recording. These response records are input to CODAP (Comprehensive Occupational Data Analysis Programs). CODAP uses clustering techniques to distinguish jobs within an OF and to determine job relationships.

6. Analysis Phase. Analysis of CODAP printouts reveals variations in job duties and relationships that can lead to improvements in OF classification, assignment, training, grade and MOS structure, job requirements, and job validation.

7. Final Report Phase. A final report is prepared that describes the results of task analyses and makes recommendations for changes. Approved recommendations are implemented by Headquarters' directives.

This systematic procedure is followed for each OF studied.

The Task Analysis Program is managed by the Manpower Plans and Policy Division (Code MPU), Headquarters, U.S. Marine Corps. Task Analysis (TA) studies of Occupational Fields are conducted by the Office of Manpower Utilization, HQMC (OMU). By early 1974, five years after the Task Analysis Program started, task analyses of eleven occupational fields had been completed. The program has accelerated since then, and by November, 1975, a total of 25 task analysis studies had been completed.

These studies have resulted in 300 approved recommendations leading to organizational changes including a reduction of billets, training savings, material savings, and direct cost and cost-avoidance savings. Results to that date showed 369 billets saved, one-time material savings amounting to $415,000, and training savings for each year in the future of 614 man-years and annual dollar savings of $5,370,617.

B. Task Analysis in Other Services

The concept of task analysis, or one of its variations, is now used by all armed services in the United States. It has also been used by armed forces in Canada, Australia and Great Britain. This wide use has encouraged the evolution of job analysis concepts, and the sharing of techniques. Thus any study of task analysis as practiced in the Marine Corps may be compared with similar work in other U.S. armed services and those of other countries. A common denominator in much of this work is the package of 40 computer programs collectively called CODAP, the acronym for Comprehensive Occupational Data Analysis Programs.

The Air Force established an operational unit in late 1967 that was charged with the construction, administration, and analysis of occupational survey data. This AF Task Analysis research group was responsible for the development of CODAP which provides the primary set of statistical programs now used by all services in analyzing task analysis data. The greatest pay-off from the occupational studies in the Air Force has been in the area of training. Significant changes have been made in every training course associated with a task analysis study. These have resulted in substantial savings and cost avoidance. The Air Force, up to the time this report is written, has concentrated upon the training implications of task analysis study results but has not used the data for the evaluation of the MOS structure within occupational fields. The latter has been the primary focus of the Marine Corps program.

The Army has an operational job-task analysis group that has been collecting occupational data using job inventories for a number of years. This group had been using its own analysis programs until just before our MC project began. It was then in the process of making several significant changes in procedures. These included the collection of worker identification data, use of the relative time-spent factor for a portion of its task list, and the use of CODAP to supplement the then existing analysis system.

The Navy conducted several large-scale occupational surveys before formally organizing a task analysis research unit. It officially established an operational job-task group in 1974 and follows procedures similar to those used in other services including use of the CODAP programs for data analysis.

The Coast Guard has been conducting occupational surveys for several years with job inventories patterned after those used in the Air Force. CODAP has been used for analyses of task inventory data. The Coast Guard had surveyed about one-third of its occupational areas at the time our study commenced.

The Canadian Armed Forces have surveyed most of their occupations using job inventories. At the time our study began, they were using their own computer analysis program but were conferring with the Marine Corps about the possibility of making use of the CODAP system.

The Australian Air Force has developed a large number of task inventories. Its instruments tend to include a large number of task statements and are generally patterned after those used by the U.S. Air Force. At least two officers from the Australian Air Force have been assigned to tours of duty working with the U.S. Air Force occupational research program and studying the use of the CODAP system for inclusion in the Australian task analysis program.

With the use of occupational analysis operational in all of the U.S. Armed Services, and in varying stages of development, and with DOD recommending interservice cooperation in these activities, the desire of the

Marine Corps in early 1974 to obtain an objective evaluation of its task analysis program was timely. The research project summarized in this report is a result of the decision of the Commandant of the Marine Corps to conduct such an evaluation. The Marine Corps Study Directive authorizing this research is contained in Appendix B.

C. Overall Study Objective

This research project was designed to provide a thorough evaluation of the Marine Corps Task Analysis Program through intensive study in several research areas. The central goal was to determine the efficacy of the task analysis process as it has been performed by OMU. This process involves the use of military analysts who prepare a paper and pencil inventory based upon observation and interview and the input of experts; on-site administration of the inventory by OMU members; and analysis on a percentage of time basis at the task level, by processing through CODAP programs.

A basic objective throughout this research has been to identify and define promising improvements and refinements in the task analysis process that could be implemented to produce an even more effective program than that conducted by the Marine Corps for some five years, from late 1969 through 1974. It was also hoped that we might discover possibly superior alternative procedures that might merit recommendations for consideration.

D. Assumptions

The primary operational assumptions for the eight research areas in this study include:

1. Background materials (or secondary data) would be made available for use by our research staff. These data, to mention a few examples, would include full data on OPs that have been analyzed by OMU and selected for study by our staff, data stored on computer tapes that would need to be subjected to various statistical treatments, data previously collected on worker characteristics, and combat scenarios that might be useful in Research Area 7.

2. Cooperation could be obtained from agencies and commands in the Marine Corps to obtain information not available within OMU.

3. Pre-testing of techniques and instruments developed in the study could be accomplished both within the OMU organization and in other areas of the Marine Corps when deemed essential for success of the research effort.

4. The Marine Corps will continue at its same relative size, and its mission will not change significantly in the foreseeable future.

A special word of appreciation is in order in connection with Assumptions 1 through 3. We have received the fullest measure of co-operation from the Director of OMU and all members of his staff throughout our entire study effort. We have also received excellent cooperation from the several other Marine Corps agencies and commands that have aided us in the collecting of data and have provided other information that has been important to our research. We owe a further debt to OMU for its effectiveness in "paving the way" for our contacts with other divisions and commands within the Marine Corps, and thus ensuring the cordial reception and cooperation we received from all Marine Corps personnel. We appreciate the level of cooperation we have been accorded. It has aided us substantially throughout our research efforts.

The next section describes the objectives, methodologies of study, findings, conclusions and end-products of the eight Research Areas designated for study by the Marine Corps Study Advisory Committee for Evaluation of the Marine Corps Task Analysis Program.

III

AREAS OF RESEARCH

Eight areas of research were identified for priority attention in this study. These are listed below by topical heading. Following the list is a summary description of research in each area with a capsule statement of end-products in each research area.

Research Area 1. Task Analysis Observation and Interview Procedures.

Research Area 2. Task Inventory Construction.

Research Area 3. Occupational Field Sample Size.

Research Area 4. Computer Procedures and Data Analysis.

Research Area 5. OMU Organization and Personnel.

Research Area 6. Orientation, Training and Team Performance.

Research Area 7. Peace-Time Task Analysis and Its Relation to War-Time Conditions.

Research Area 8. The Use of Worker Characteristics in Classification and Assignment.

A. Research Area 1. Task Analysis Observation and Interview Procedures.

Interviewing plays a key role in both the study phase and the observation-interview phase of the Task Analysis process. During the study phase, Task Analysis team members interview sponsors and monitors of the occupational field (OF) being studied to gain background information and attempt to make initial identification of problem areas. Service schools providing training in the OF are visited by team members, who interview instructors and other staff members and may interview students.

Highly important to development of task statements for the Task Analysis Inventories are interviews conducted in the field by team members with incumbents of the OF as well as direct observation of personnel in performing assigned tasks. Team members interview officers and NCOs of various ranks and non-com incumbents during the O&I phase.

Observation and interviewing procedures were not standardized among TA teams at the time this study commenced. No specific course of training was provided on a regular basis to new team members. As a result, effective-

ness of the process varied widely as a function of individual personalities and levels of education and training of both interviewers and interviewees.

The specific objective of research in this area was to increase the effectiveness of the observation and interview process to provide complete and accurate information in the development of task analysis inventories. As a means to this end, we proposed to develop instructional materials for the orientation and training of new members of task analysis teams and for upgrading the skills of present members. Work to meet this objective has been coordinated with that of members of the project staff in Research Area 6 who have developed additional training materials for OMU personnel.

Methodologies, Findings, Conclusions and End-Product. Primary research in this area involved extensive interviews with the Officers and SNCOs of the OMU staff to obtain their perceptions of the O&I process, its importance in developing task statements for interviewing, methods employed by them in the field, the training they had received upon arrival for duty at OMU, and suggestions they might have for improving the process. A survey of the literature on observation and interviewing was conducted. Consideration was also given to alternate methods of gathering data for task inventories. As examples, among a number of methods reviewed were group interviews, use of "expert" panels, and the critical incident method.

On-the-job training proved to be the primary method of preparing new incumbents for their role in the O&I process. None objected to this, but all felt that some type of formal orientation and training before going into the field would have made them more useful earlier in their tour of duty and less uncomfortable in doing a job for which they felt ill-equipped. Many said they were shown a book shelf with a number of technical manuals and told to read them and then get to work. A majority found the materials, such as the CODAP Manual, confusing or too technical to be helpful. A common comment was that "it takes at least a year, and sometimes two, for us to feel that we are really prepared to contribute to our team's effort". This was especially frustrating for the SNCOs, all of whom were experts in their own occupational fields, with many years of experience in their specialties, but they felt like "a fish out of water" in their new duties at OMU.

The conclusion was unequivocal. Early, more formal orientation and training is needed to accelerate the usefulness of newly assigned personnel and to reduce their frustrations and feelings of inadequacy during their first year or more as members of the OMU staff. Inasmuch as the normal tour of duty in OMU is three years, development of procedures to increase productivity of new staff members earlier in their tour appeared to be important not only in increasing OMU's effectiveness in its mission of improving manpower utilization but also in maintaining the morale of its staff.

The conclusion from reviews of alternate methods of data gathering was

that a more thorough review -- during the Study Phase -- of training manuals and other documents describing OF tasks, when followed by interviews and reviews with "experts" of preliminary task statements, speeded up the process of developing task statements for inventories and shows promise of reducing time and costs in the O&I Phase. This finding is based upon experiments conducted by OMU at our suggestion.

The end-product of this research, aside from the many interim reports prepared, and discussion with OMU officers of methods for improving training, is Technical Report No. 2, Training Guide for Observation and Interviewing in Task Analysis, Training Manual III. This Training Guide is designed to provide basic orientation to Task Analysis and detailed suggestions for carrying out the entire observation and interview phase of the Task Analysis process. Various procedures for job analysis are described in terms of the most common methods and their advantages and limitations. Special attention is directed to requirements of reliability and validity in the collection of Task Analysis data and to recommended procedures for meeting these requirements. To ensure the quality of findings in studies of Marine Corps Occupational Fields, specific recommentations are given for all major steps in the data-gathering process including improving interviews by checking questions, building respondent motivation, developing listening ability, managing the interview, and improving both observation and the recording of information.

B. Research Area 2. Task Inventory Construction.

It has been a traditional assumption of OMU that the more items included concerning tasks in a specific occupational field the greater the opportunity for evaluating tasks as they are really performed in the field. The result of this policy is that a task inventory may contain as many as 1000 items. It is considered possible that an inventory of significantly fewer items would permit task discrimination within OFs while reducing fatigue of inventory respondents, would improve reliability and validity, and reduce costs of administration and subsequent data analysis.

Perhaps equally important is the wording of task statements. Many inventories reflect ambiguities in some statements. In others, words and phrases may be used that are not understandable to some inventory-takers because of their limited educational backgrounds, deficiencies in reading skills, and in some cases, differences in service school training backgrounds. Also investigated were the design and format of inventories and alternatives that might be more efficient; anonymous responses vs. identification of respondents; attitudes of respondents about readability, length and coverage of task inventories; and differences in responses between officers and enlisted Marines and differences among Marines in different pay grades.

The specific objectives of this research were to determine an optimum inventory size that would have equal or greater effectiveness than previous inventories, and to develop procedures for the phrasing of task statements to avoid ambiguities and be understandable to as broad a range of Marines as is possible with a paper and pencil instrument. A related objective was to develop recommendations for inventory design and format.

Methodologies, Findings, Conclusions and End-Products. Methodologies in this research area were many and varied. As in most research areas of our project, interactions with OMU staff members in Quantico, at Cal State L.A., by telephone and by correspondence not only provided important information for our research efforts, but they also led to implementation during the course of our research of changes resulting from findings and suggestions that were a result of these interactions. Because of this, actions that would ordinarily be considered for implementation following a final report were effected as the research progressed. This result is perhaps most notable in the changes in design and format of Task Inventory booklets.

When the study commenced, OMU was using a two-booklet format. One booklet contained a set of instructions, a section on background information about respondents, a set of task statements and a job satisfaction questionnaire. A second booklet contained spaces for recording answers. Responses in the answer booklet were read by an optical scanning device. However, a considerable amount of time had to be spent by team members in erasing random marks in the booklets that could create errors in the scanning process. This was a slow and tedious task. Aside from this problem, Marines completing the inventory were required to go back and forth between the two booklets to record responses to each item. The chance for error on the part of respondents could generate the possibility of reduced reliability and validity of results.

The use of answer sheets adaptable to optical scanning to replace the answer booklet was studied. One alternative considered was a Westinghouse system. However, this involved a considerable capital investment in new scanning equipment. This was rejected as incompatible with the Marine Corps efforts to reduce costs. Adaptation of the Air Force Task Inventory answer sheet was reviewed. The Air Force offered its assistance in "reading" the answer sheets at Lackland AFB with its OCR system. Time factors and costs suggested that other alternatives be reviewed before a final decision was made.

The result of these studies was preparation of a single task inventory booklet that includes response categories to questions and task statements on the same page and immediately following the items. It is designed for direct key-to-disk recording of the responses that are pre-coded on each page. The initial task inventories that have been prepared for trial in this manner have produced satisfying results. Basic processing costs are substantially lower than those of the older system, and considerable staff time has been saved by elimination of the answer booklets that required cleaning up in

preparation for the former scanning process. The new format appears to be less prone to response errors than the answer sheets considered, and the separate answer booklets used previously. It also appears that chances for error in the process of transferring responses from booklets to computer tape have been reduced.

Throughout the study of task inventory formats, OMU took the initiative in investigating alternatives and evaluating the cost-benefits, reliability and practicality of different systems. Members of the OMU staff not only deserve recognition for these efforts, but they must also be given credit for development of the new format and scoring system, and for conducting experiments that have demonstrated the values of the new method.

It has been traditional in both the Marine Corps and the Air Force Task Analysis Programs to require task inventory respondents to write their name, service number, organizational unit and other identifying information on the inventories they complete. This has been considered important to make possible later contact with individuals to clarify questionable responses as well as to make feasible the study of sub-samples for special purposes. A question arose during the course of our research as to whether or not anonymous responses might provide more reliable data. Our hypothesis was that anonymous responses would be more valid than those where individual identification of respondents was possible. The Director of OMU offered to conduct a study to test this hypothesis.

Each Marine Corps task inventory includes a 28 item job satisfaction questionnaire. The assumption was made that this portion of the inventory is most susceptible to bias when respondents are identified. This assumption was based upon the nature of some of the items in the job satisfaction questionnaire. These related to how well a Marine's supervisor handles his job, how well the Marine is treated by his superiors, and similar questions judged to be sensitive when respondents know they can be identified with their answers. As a result, this portion of a task inventory was chosen for use in testing the hypothesis.

Two equal size random samples of Marines were selected. Marines in one sample were asked to complete the identifying information called for on the task inventory questionnaire. Marines in the other sample replied anonymously. Statistical tests of the significance of differences between the two groups showed responses to only four of the 28 items to be significant at the .05 confidence level. Surprisingly, none of these four items was among those we hypothesized would be most sensitive to bias with respondent identification. Our conclusion from this study is that, in the Marine Corps setting, only minimal and generally non-significant differences result from identified respondents to task inventories as compared with anonymous administrations. The Air Force came to this conclusion some time ago in its task analysis studies, and it continues to require identification of respondents on task inventories. OMU, however, has not found sufficient reasons to continue the requirement of attributed responses. The purposes

of its TA program are as well served with anonymous responses as with identified respondents. As a result, and in the spirit of the Privacy Act, respondent identification is no longer requested.

In the early stages of our research our primary concerns about task inventories were the very large number of items in most inventories and the readability of inventory instructions and task statements. Literature reviews resulted in a concensus that questionnaires requiring more than one half hour to an hour to complete should be avoided. It is contended that longer questionnaires lead to fatigue, diminished interest in completing the task, and probabilities of reduced reliabilities. Reviews of the experiences of the Marine Corps over a period of some seven years and that of the Air Force for some nine years, at the time this report is written, suggest that the conditions of administration of questionnaires and inventories in a civilian setting may be quite different from that of administration of similar instruments to military personnel in a more disciplined situation. Reports of difficulties arising from length of inventories in both services have been extremely rare. Two of our studies tend to support the feasibility of using lengthy questionnaires in military organizations.

One study was designed to assess attitudes of Marines following completion of a lengthy task inventory. Primary areas covered by the survey were length of the inventory, its difficulty, its interest, coverage of the tasks in the Marine's MOS, and the terminology used on the job. One question asked how the Marine felt about describing his MOS duties. This was followed by a free response or "comments" section. Unfortunately, only small samples could be obtained from three OFs, and no low technology OFs were being inventoried at the time of the study. The results, however, could be significant, if OMU conducts similar surveys in the future, as we recommend, and obtains similar findings.

We found that the majority of Marines in our samples reported the inventories were not too long, were not difficult to complete, did not include words that were hard to understand, and that task statements well described their duties. A large majority also indicated that they appreciated the interest the Commandant showed in them and in their specialty by preparing and administering the inventory. They seemed pleased to have the chance to tell what they actually do on their jobs.

A second study was based upon the hypothesis that the lengthy inventories would reflect unreliable responses in terms of lack of logical differentiations between Officer and NCO tasks and among NCOs in different pay grades. Statistical analysis of task inventories for three OFs involved comparison of response distributions, analysis of variance, and tests of significance of differences between officers and NCOs and within the NCO groups. Results disproved the hypothesis. The analyses reflected logical differences between tasks performed by officers and NCOs. There was some overlap in the higher NCO pay grades, as would be expected if data were reliable, since both officers and senior NCOs are supervisors and not primarily technicians. Logical differences were also found among NCOs in different pay grades. NCOs in the middle pay grades were performing

technical tasks appropriate to their ranks, and lower level enlisted grades were performing more routine tasks.

Some members of our staff are still very much concerned about the length of OMU's task inventories. Their literature search revealed a multiple-booklet approach, used in a study of temperament factors, that reduces the number of items presented to each inventory respondent. This system has been recommended for trial by OMU.

In the temperament questionnaire 25 factors comprising 400 items plus a 20 item desirability scale were distributed among 30 overlapping booklets each to be administered to a separate sub-sample of the experimental group being studied. The experimental design required that items representing five of the 25 factors be given to each of the 30 samples, while each factor appeared in six different samples so that comparisons among all factors could be made on a statistically sound sampling basis. These overlapping booklets have been labeled "mini-booklets" by staff members who have recommended their experimental trial in a task analysis study. Principles for applying the experimental design in development of the booklets are included in the final technical report for this Research Area.

The most extensive studies in this Research Area involved analyses of the readability of task inventories and measures of reading ability levels of samples of enlisted Marines at three West Coast Marine Bases. In the first phase of these studies, the reading levels of nine Marine Corps task analysis inventories were evaluated by using four standard measures of readability. The four measures are the Dale-Chall Readability Formula, the Flesch Readability Index, Gunning's FOG Index and McLaughlin's SMOG Grading. Readability of both task inventory instructions and task statements was measured. Readability scores are expressed in terms of school grade presumably required to read and comprehend the material evaluated.

Results of the readability analyses showed considerable variation among the four measures applied. For example, in one OF two of the measures indicated the inventory was written at the level of a college junior or a college senior, another indicated that the 10th grade level of reading ability was appropriate and the fourth indicated an individual had to be half way through the eleventh grade to understand the material. A further review of the literature was then made to try to obtain information to assess the discrepancies. The final technical report for this Research Area discusses variations among the different measures and attempts to provide some explanations.

One benefit of our extended literature search was discovery of a method that is specifically designed for use with standardized tests that may have some sections composed of word lists and other sections with short sentences or statements. This measure is the Forbes-Cottle Method for Determining Readability of Standardized Tests. Inasmuch as tasks in task inventories are described by short sentences or statements, this method was deemed to merit special attention. We applied it to the nine inventories, and it is the conclusion of our staff that the Forbes-Cottle is probably the measure best adapted to determining readability of task inventories.

The averages of the five readability measures suggest that a Marine should have a reading level equivalent to at least a 10th grade student, or in some of the nine inventories, at least the 11th grade, and in one that is a low technology OF prepared early in CMU's TA program, a Marine would need to be a high school graduate to understand the task inventory instructions. Task statements appear to be written at even higher levels. However, there is evidence that discussions we have had with CMU staff members about problems of readability, coupled with quarterly and other interim reports discussing our findings, have been useful. The instructions for a task inventory recently prepared for officers in a sophisticated OF are written at a lower readability level than an inventory prepared over two years ago for a low technology enlisted OF.

In order to determine what readability levels are appropriate for task inventories, it is necessary to have a reasonable estimate of the actual reading level of Marines to whom a task inventory is administered. We hypothesized that Marines in the lower technology OFs would have lower reading abilities than Marines in high technology OFs because of differences in entry selection standards. CMU assisted us in making arrangements at three Marine Corps bases to test this hypothesis. The bases selected were El Toro Marine Corps Air Station where we sampled Marines in relatively high technology OFs, Camp Pendleton where a sample of Marines in low technology OFs was obtained, and at the Marine Corps Recruit Depot, San Diego where we obtained a cross-section of permanent staff personnel representing a variety of OFs. The Gates-McGinitie Reading Tests were used to assess reading comprehension ability levels.

Results of the testing supported the hypothesis. The majority of Marines in the higher technology OFs at El Toro scored considerably above the average of Marines in low technology OFs at Camp Pendleton. However, although the Marines tested at El Toro (as well as those at MCRD,SD) were part of a carefully selected random sample covering all paygrades, those at Camp Pendleton were primarily in pay grades E-1 through E-5. The same sampling procedures were prescribed for all three bases. We have been unable to find out what went wrong at Camp Pendleton. However, results in the pay grades that can be compared do support the hypothesis. Results at the MCRD of a cross-section of Marines in a variety of OFs and all pay grades suggest that no serious reading problems exist among the majority and that Marines assigned to permanent staff at a base of this nature are probably assessed against a fairly high selection standard. However, in all groups there were some Marines whose reading comprehension levels were below that required for ready understanding of Marine Corps task inventories as they have been prepared in the past.

Several conclusions may be drawn from the readability studies. CMU has made some progress in the last two years in improving readability of inventory instructions. More still needs to be done, and continuing efforts to write both inventory instructions and task statements simply and clearly are required to help ensure the reliability of information gathered by task inventories. As a form of quality assurance, it is recommended that

periodic application of readability measures be used to evaluate task inventories, and that administration of an attitude survey similar to the one used in this research area be used to monitor the reactions of Marines to future task inventories.

The end-product of this Research Area is Technical Report No. 14, Task Inventory Construction. It describes research efforts in this Area and gives detailed findings. Attention is given to problems in task inventory construction and administration, and recommendations are given to overcome them.

C. Research Area 3. Occupational Field Sample Size.

It has been the policy of OMU to administer a task analysis inventory to the largest possible sample in an occupational field. Our studies show it had not been uncommon for the sample to include as high as 20 percent of the personnel in a large field, and to be as high as 70 percent in an OF with only a few hundred incumbents. The ramifications of this policy extend to sample sizes that appear to be in excess of statistical requirements for effective analysis and create greater costs for administering and scoring inventories than may be necessary.

The specific objective of research in this Area was to develop guidelines for decision-making by the OMU staff in the selection of OF sample sizes to which Task Analysis Inventories will be administered. Advantages and disadvantages associated with various levels of N were to be specified, as they relate to OMU priorities and practices. Potential effects of variations in methods of drawing samples, and sample characteristics which may interact with response reliability, were also to be identified.

Methodologies, Findings, Conclusions and End Product. Research methods in this Area involved a variety of approaches. The initial literature search was supplemented by later reviews as the study progressed. Procedures for sample selection utilized by OMU were compared with alternate methods and discussed with members of the OMU staff. Consultations were held with a number of researchers known for their work in the field of sampling. Several computer studies were conducted employing a variety of statistical techniques. Six of the eight research tasks proposed for this Area were completed. One research task was discarded because of restricted access to IBM CODAP programs at the time of our study. Another was cancelled due to its impracticality under OMU travel budget restraints. One new research task developed as the study progressed and was addressed as significant to this Research Area.

A comprehensive study was made of responses to 20 of the questions in the Task Analysis Inventory for OF 40. Selection of questions was based upon pre-set decision rules. For each question, 34 random samples were selected, two of equal size for each of 17 sample sizes ranging from an N of 30 to N=700. The percentage of responses of Marines to each of the eight response categories (on a 0 to 7 scale) for each of the subsamples

was then determined. Means and variances were also calculated for each sub-sample. A review of the data indicates that a sample size of between 320 and 500 provides a stability of responses with sufficient consistency so that decisions can be made from the data with confidence. Similar analyses were then made of responses to Task Inventories for OF 41 and OF 43. The results for both OFs are almost identical to those obtained in the OF 40 study.

Our analyses of these data have led to the conclusion that a sample size of 400 should be adequate for purposes of the Task Analysis process in most OFs. This conclusion is dependent upon proper representative selection of the Marines to be included in a sample. No less than 30 to 40 Marines should be included in each pay grade. Where this is not possible in the top two pay grades, every effort needs to be made to include the maximum number available in these higher pay grades.

Results of the stability tests described above were supplemented by data from the literature, a review of the Army's sample size studies, and discussions with outside consultants. Our literature review revealed a statistical method that yielded an optimal sample size of 400 when a confidence level of .05 is considered acceptable.

Review of studies by the Army Military Occupational Research Division demonstrated that a sample size of 384 is adequate for Task Analysis studies provided representative random sampling procedures are used in sample selection. A somewhat different formula, but based upon similar statistical methods, was recommended by an outside consultant. Application of this formula yielded an optimal sample size identical with that of the Army's research -- 384. It is the opinion of the research staff that these additional data support results of the stability tests we conducted that indicate a sample of 400 is the minimum for task inventory administration, and that larger samples may not be required in most instances.

The research task that was added during the course of our study is not directly related to sample size, but it is important in sample selection and OMU's cost effectiveness. All task analysis studies conducted by OMU have included O & I studies and task inventory administration both within the United States and at overseas bases. The high cost of studies at distant overseas locations became a matter of concern for us because of the substantial reductions in OMU's TAD budget that occurred several times during the period of our research. We made the decision to investigate the differences between data obtained overseas and that gathered within the CONUS. OMU promptly assisted us in this study by providing us with computer printouts of the responses to several task inventories by Marines assigned to East and West Coast U.S. bases and those stationed at overseas bases. Statistical studies indicated that the most significant differences among the three groups were between the East and West Coast groups. Our conclusion from these "pilot" studies is that there are probably no significant differences with respect to population parameters that should cause concern about eliminating overseas sampling in the future. However, it was not possible within the scope of

our research to follow-up with a study of the effect upon clustering that might result from eliminating overseas sampling. OMU has the data and the capability for conducting what we view as a "pay-off" study on this topic. It is recommended that this be done as an in-house project. A suggested experimental design for this additional research is given in Technical Report No. 11.

The end product of this Research Area is Technical Report No. 11, Guidelines for Sampling in Task Analysis. It discusses principles of sampling with cautions that need to be exercised to ensure obtaining reliable random and representative samples. Included is a review of the characteristics of an optimum design. Findings of our studies are presented which provide an empirical basis for defining sample size. As its title suggests, it is a guide to aid OMU in the selection of samples for future task analysis studies and it recommends a generalized sampling strategy for adoption by OMU that will provide reliable data that can be acted upon with confidence.

D. Research Area 4. Computer Procedures and Data Analysis.

The completed task analysis inventory is processed by using a number of computer related procedures designed to yield outputs that can be interpreted to support the task analysis process. These procedures include methods of input such as key-to-disk recording of responses in task inventory booklets, the analytical algorithms in the CODAP system, the CODAP system user manuals, and the various out-put formats produced by the CODAP system. There seemed to be a likelihood that the efficiency and effectiveness of all of these computer related procedures could be improved. Methods of analysis using the CODAP system, at the time this study was initiated, were based upon a number of assumptions. One such assumption was that "a 35% homogeneity will group tasks together and thus form a job". We found no evidence that this assumption or other assumptions in use of the CODAP system had been tested objectively by the OMU TA staff. It was believed that the full analytical capabilities of the CODAP system had not been fully exploited. There exist in the CODAP system a number of statistical techniques, that if adapted to Marine Corps computers, could improve the overall effectiveness of its application in the analysis of task inventory data.

The specific objective of research in this area was to improve the efficiency and effectiveness of computer procedures and subsequent data analysis in the task analysis process.

Methodologies, Findings, Conclusions and End Products. A comprehensive review of the literature on various methods of classification was made, with special attention to clustering techniques, in order to assess the values of alternate methods to the CODAP system. In other areas of our research a variety of statistical techniques were used in analysis of data, but the majority of studies were conducted using analysis of variance, chi-squared,

and t and F tests for evaluating the significance of differences. Discussions with computer experts on the OMU staff were held over a period of time both as a learning experience for our staff in developing information for evaluating the CODAP system and as a means of exchanging ideas as our evaluation progressed. We had hoped to obtain a computer program for CODAP so that we could conduct experiments with CODAP on our own computer. However, contract restrictions on the use of IBM versions of CODAP programs prevented us from completing the research tasks we had proposed for these experiments. (Unfortunately, we did not have access to a UNIVAC for which CODAP programs were not restricted.) On the other hand, some additional research tasks were included in our study efforts when questions arose during the course of our investigations that had not been foreseen at the time the Study Plan was prepared.

A question in this research area has concerned the adequacy of CODAP for analyzing the data gathered through administration of task inventories. Much of our work in this area has dealt with CODAP's cluster-forming procedures. We have also studied the logical adequacy of the CODAP package. In our reviews of alternate systems we found that there are some more sophisticated programs available, and a number of others are less expensive in terms of computer time. However, we have found none that has CODAP's large capacity for cases and items. CODAP has the advantage of being able to handle a 2,000 by 2,000 matrix. In view of the number of task statements in some Marine Corps task inventories -- 900 to 1,000 -- CODAP appears to have the capacity for more complete analysis of Marine Corps task inventory data than any other program we have encountered. Based upon studies in this Research Area and in Research Area 3, we feel justified in concluding that the processed results from CODAP are fairly reflective of the reality of the tasks that Marines perform. It is our assessment that CODAP is adequate to meet OMU's requirements.

In its analysis of the hierarchical tree printouts resulting from CODAP's cluster analysis, OMU has used a range of from 35% to 50% of homogeneity to determine a cluster that defines a specific job. Our studies suggest that there may be times when an even smaller level of homogeneity may be warranted. These would be special cases but they should not be overlooked in these analyses. The final Technical Report for this Research Area discusses the evaluation of clusters in this part of OMU's data analysis and provides specific recommendations.

A research task that we had not proposed earlier but did include in our study arose when we found that most task inventories include a number of military or general duty items that are common to most Marines but do not necessarily relate to the specific tasks in a given occupational field. During the O&I phase of TA studies Marines are asked to state all of the tasks that they perform. As a result, these non-occupational duties are reported by Marines and therefore show up in task statements. It has been logically argued that such items should be included since they represent part of a Marine's day. However, we became concerned about what effect inclusion of these non-occupational duties has on clustering.

We conducted several studies on this and have concluded that inclusion of military duties in a task inventory creates serious chances for bias. For example, when such duties are included, certain Marines form a cluster showing a distinct job. When these duties are excluded from analysis, and only duties specific to the OF are included, the same Marines cluster in different jobs. Based upon these results, we recommend that OMU perform two cluster analyses for each OF study, one including the general duties and one without, and then, compare the results before making decisions about job categories within the OF.

Following the lead of the Air Force, OMU uses an 8-point scale for responses to task inventory statements. Range of the scale is from 0, "I don't do", 1, "Rarely do", to 7, "I do very much". Reviews of the results of a number of task inventory administrations showed that aggregate responses rarely reflect an even distribution over the entire scale. Instead, the largest number of responses appear at the "4" or average range with a few less at the "1" and "7" ends of the scale and very few in-between. This was discussed with the former head of computer operations who reported he had observed the same phenomenon. He called it the "Sombrero effect". He too had found a high peak for responses in the middle of the scale, with a sharp drop-off on either side, then a rise at each tail of the distribution, much like the profile of Mexican Sombrero curled up at the outer edges. Although both the Air Force and the Marine Corps have talked about expanding their response scales to 9 or even 11, our research suggests this may be counter-productive. A shorter scale could be equally useful. We have discussed this issue with the head of the Air Force Task Analysis Research Program, and he reported he had wanted to expand to a 9 point scale for some time. However, he had not done so because of the difficulties in assigning appropriate labels to all 9 points on his proposed extended range scale. This issue of scaling is discussed in the final technical report for this Research Area. We believe research by OMU on different ranges in response scales could be useful, with a promise of profitable results.

End products for this Research Area include several technical reports. Technical Report No. 1, Hierarchical Clustering: A Bibliography, presents a comprehensive list of references on clustering techniques and other methods of classification resulting from our research of the literature. Technical Report No. 4, Guidelines for Research Planning and Design in Task Analysis, focuses upon Task Analysis as research. It is based upon the fact that OMU's TA program involves purposive, systematic investigations and analyses in order to prepare reports of findings that will be useful and influential in Marine Corps planning, policy determination, and management. Guidelines are presented for the planning and design of OMU's projects in accordance with recognized criteria of dependable scientific research in order that they will justify proper respect and credibility and thereby achieve maximum impact and value. Technical Report No.15, Computer Procedures and Data Analysis in Marine Corps Task Analysis, is the third end-product of this Research Area. It discusses research tasks reviewed above. In addition, it provides an introduction to clustering that is

designed primarily for staff members of our study sponsor, and a discussion of deviant scores or "outliers".

E. Research Area 5. OMU Organization and Personnel.

The essential questions covered in this area of research include the procedures for selection of Marines for duty in Task Analysis, the impact of task analysis team naivete, effectiveness of present team size, methods employed in team selection, and a review of the effectiveness of the then existing organizational structure of the Office of Manpower Utilization. One question to be answered was whether or not personnel selection procedures provided an optimum mix of abilities and competencies within task analysis teams. Also, it was hypothesized that the internal composition of teams and their size might not be cost effective.

Would centralizing such functions as task inventory construction and final report writing improve task analysis effectiveness? Are there jobs within OMU that might be filled more effectively by civilians than by Marines? It was believed that a study of the organizational structure of OMU might provide information that could lead to improvements in the overall effectiveness of task analysis in the Marine Corps.

The specific objective of this research area was to review the total OMU organization by an in-depth analysis of the structure, and if indicated, recommend alternatives that could lead to increased effectiveness. Important related objectives were determination of the most effective task analysis team structure, team member qualifications, and improvements that could be made in team member procurement and selection.

Methodologies, Findings, Conclusions and End Products. A combination of primary data-gathering approaches was used for this Research Area. These developed into three phases. Phase I included individual depth-interviews with OMU officers and staff, focused group interviewing, direct observation, questionnaires, and telephone and mail interchanges. This exploratory phase helped to identify relevant problems and assure that the researchers were asking the right questions. Phase II was primarily a data-gathering effort geared to answering questions generated in Phase I. Phase III was devoted to collecting additional data, analyzing data, collaborating with OMU in planned organizational change efforts, and documenting research efforts and results.

Research in this Area was facilitated by the intensive cooperation of the staff of OMU. A variety of organizational forms were considered during the course of the study in discussions between staff members of OMU and our research staff. One of the early concerns related to the practice of organizing the OMU staff into independent teams, each of which was assigned full responsibility for conduct of separate OF task analysis studies. Although this team concept appeared to be consistent with organizational approaches in the Marine Corps and provided a locus of control for conducting OF studies, it had contributed to a number of major problems. Among these were: non-standardization in the conduct of OF

studies, dysfunctional competition among teams that prevented effective communication, and ineffective manpower utilization within teams that contributed to substantial down-time.

A concensus was reached in discussions between our staff and that of OMU that a change in the structure of the organization could contribute to enhancing organizational effectiveness provided it was combined with other actions. Several alternatives were developed that ranged from retention of the basic teams, reduced in size and modified to include civilian specialists in such areas as cluster analysis and report writing, to a matrix form of organization where staff needs would be drawn from a manpower pool on an "as available and as needed" basis. The organizational change agreed upon was a compromise between these two. It should be noted that the new organization remains essentially military. The employment of civilians in certain specialty areas was rejected after a full review of the consequences.

Within the resulting reorganization that was implemented in mid-1975, explicit attention is given to specialization. Computer programming, data analysis, and report writing are specific areas of specialization. A Support Element was established whose members are semi-specialized and their training and efforts are concentrated in one or two Task Analysis phases in order to become expert in those areas. At the same time, flexibility is retained in the interest of maximum utilization of personnel resources, so that any Support Unit member may be assigned to any Task Analysis project. Results to date indicate that the new organizational structure has reduced or eliminated many of the problems identified in the earlier phases of our study, has increased the effectiveness of OMU and improved morale among its staff members.

Many other areas were addressed in this phase of our research, but the details are too numerous to include in this summary report. The final technical report provides a frank discussion of all problem areas addressed, findings, conclusions and recommendations. Among the factors reviewed are problems of planning and coordination, communications among units of the new organization, naive personnel, selection and assignment of officers and NCOs to the OMU staff, considerations of staff morale, and report-writing.

One part of the studies in this Research Area does appear to merit special attention in this summary report. This is the selection and assignment of personnel to OMU. Past practice of selection of officers for duty on the OMU staff appeared satisfactory to us, with but few exceptions. Officer specifications provide that seven officers, of the eleven authorized, possess post-graduate degrees. The favorable impact of this is apparent. On the other hand, the selection of high quality SNCOs for OMU duty has appeared to be more a matter of chance than design. Some improvements have been made since the new organization became effective. Whether these changes will provide the "mix" of Marine Corps experience that may be most appropriate for accomplishment of OMU's mission is yet to be tested.

In the early stages of our research we encountered several SNCOs on the OMU staff who, although highly skilled in their own OFs, had not had experience or training in the type of communication skills required for OMU duty. A number of SNCOs resented their assignment to OMU and did not view it as prestigious in their careers to be selected for duty with HQMC as have most officers. More individualized selection of SNCOs for OMU duty than now exists appears to be one means of avoiding similar problems in the future. It is our recommendation that the Director of OMU be given the opportunity to review the service records of SNCOs proposed for assignment and be a direct participant with the monitor in their selection. He should also have the right of veto.

The end products of this research are three technical reports. Technical Report No. 6, OMU Organization and Personnel, is a complete documentation of methodologies, findings, conclusions and recommendations for this Research Area. Two other technical reports were prepared during the course of the study when needs were identified that our staff felt should be addressed.

Technical Report No. 3, Program Evaluation and Review Technique (PERT): A Planning and Control Tool for Occupational Field Studies, was prepared when it was determined from our research that a systematic method of planning, scheduling and control of OF studies would be of operational value to OMU. PERT was selected as a method to aid OMU in these areas since it can be useful in developing a detailed implementation plan -- including scheduling work, estimating time requirements, determining staffing needs, and pin-pointing check points for reports on and control of an OF study. The report on PERT can provide ready reference materials for individuals involved in designing, directing, planning, and controlling OF studies. It can also be used as training material for new personnel to introduce them to techniques of planning and control in OF studies. The description of PERT in this report is specifically addressed to Task Analysis as conducted by the Marine Corps.

The third end product for Research Area 5 is Technical Report No. 5, Management Auditing. Preparation of this report commenced at a time when OMU was faced with a severely reduced TAD budget, and there were indications that the scope and number of future TA studies would also be reduced. Inasmuch as OMU holds major responsibility for Marine Corps research in human resources management, it was believed that its talents in research should be further utilized. The report suggests that OMU's services and contribution might be increased by broadening OMU's assignment so that its staff could offer management auditing service on an optional basis to Occupational Fields that request such assistance.

F. Research Area 6. Orientation, Training, and Team Performance.

At the time this research was initiated, the training and orientation process of newly assigned task analysis team members was essentially a casual process. There was no structured presentation to new members of the total task analysis process, their specific duties, or a planned discussion of experiences of more senior members in conducting task

analyses. Perhaps as a result of this casual instruction, task analysis team members did not reach a maximum level of usefulness until after a year or more of experience on a team. During this trial and error learning period, the productivity of new team members appeared to be a function of the interest they took in attempting to learn about the task analysis process, their level of intelligence and their educational backgrounds. It was considered probable that a structured program of training and orientation would bring team members to a higher level of performance more rapidly and thereby extend their effective productivity over a longer portion of their tour of duty with OMU.

The specific objective in this area of research was to develop procedures and training materials designed to minimize the amount of time required to orient and train new team members, maximize the period of time in which they would be fully productive on a team, and maximize their productivity throughout their assignment to the OMU staff. A corollary objective was to provide training methods to upgrade the skills of current members of task analysis teams.

Methodologies, Findings, Conclusions and End Products. Methodologies in this Research Area closely paralleled those in Research Areas 1 and 5. In fact, data gathering for each of the three areas was conducted concurrently in many instances. Information obtained for one Area was promptly shared with staff members whose efforts were primarily concentrated in other Areas. This proved to be effective not only in reducing some of the costs of data collection, but it also provided different perspectives on similar problems because of the somewhat different points of reference of members of our inderdisciplinary staff who made observations on the same phenomena. Inasmuch as methodologies were almost identical in all three Research Areas, and these have been described in the discussions of Research Areas 1 and 5 in this report, it is deemed to be unnecessary and would be redundant, to repeat them in this section of this final summary report.

All research tasks proposed for this Research Area have been completed with the exception of a final project technical report. The latter has been considered to be unnecessary in view of the variety of Training Manuals that are technical reports resulting from research in this Area. These Manuals are based upon findings from studies in this area of our research and provide materials that we hope will be of value to OMU in its training of newly assigned staff members and in upgrading the effectiveness of more experienced personnel. However, one research task not mentioned in other reports deserves mention here. A demonstration problem-solving seminar was conducted in Quantico by two of our staff members for both Officers and NCOs of the OMU staff. This aided in development of both inter-team and intra-team communications within the organization and it also served as an example of the effectiveness of cooperative team work and the values of training seminars of this type. It is recommended that OMU conduct similar training sessions periodically.

End products for this Research Area include several Training Manuals.

Technical Report No. 7, Principles of Training in Task Analysis, Training Manual I, was originally prepared as a brief introduction to another training manual. However, inasmuch as it is directed primarily to those who conduct training for OMU staff members, it was decided that it would be more suitable to issue it as a separate technical report and training manual. It was therefore expanded to meet this objective. It discusses training principles as well as several different methods of training that can contribute to training effectiveness.

Another relatively brief training manual is Technical Report No. 10, Introduction to Marine Corps Task Analysis, Training Manual No. II. As indicated by its title, it is designed to serve as an orientation to Task Analysis for staff members newly assigned to OMU.

Technical Report No. 2, Training Guide for Observation and Interviewing in Task Analysis, Training Manual III, has been described in the discussion of Research Area 1, Observation and Interviewing. Although this training manual is primarily the product of the Study Coordinator for Research Area 1, who is its senior author, members of the staff of Research Area 6 contributed to development of this technical report both in terms of data collection and in suggestions for portions of its contents.

Technical Report No. 8, Communications in Task Analysis, was prepared in response to findings early in our research that communications, especially the lack of inter-team communications, represented a problem hindering the effectiveness of OMU. Due to the impact of our feed-back to OMU about our findings, and the innovative efforts of the OMU Director to resolve the problem, the need for this manual has become less urgent at this time. However, due to the rotation of military personnel in the Marine Corps, as in other military services, the need for a reference manual of this nature is considered important as a part of the training materials for future personnel assigned to task analysis duties. Of course it is hoped that it will also be useful for present staff members as a supplement to measures already taken by OMU to improve communications within its organization. As a corollary comment about rotation of duty among Marine Corps personnel, it may be noted here that in the less than two years of our study, there have been three directors of the Office of Manpower Utilization.

Technical Report No. 9, Teamwork in Task Analysis, is a response to the inter-team competition, and sometimes conflict, observed in our visits to the OMU headquarters, and revealed in our individual interviews with staff members. Each project in the Marine Corps Task Analysis program is assigned to staff members, organized to form work teams. Their continuing performance as effective teams, and their inter-relationships with other members of the OMU staff, are crucial for success of the project. This Training Manual provides guidelines for effective teamwork and work-team maintenance and development.

G. Research Area 7. Peace Time Task Analysis and Its Relation to War Time Conditions.

All task analyses of occupational fields performed to date have been conducted under peace time rather than war time conditions. This raised the fundamental question of whether conclusions based upon a set of activities inventoried in peace time apply equally well during periods of combat activity. An obstacle to full effectiveness of the task analysis process utilized by the Marine Corps and other armed forces at present is its apparent inability to evaluate jobs in terms of tasks that are not currently performed, but whose performance could become essential under changed conditions.

The specific objective of this Research Area was to determine the type of task analysis that would be effective in measurement of tasks that are not now being performed by Marines but would be performed by them in combat. The research staff had no illusions about the difficulties inherent in such an objective. However, it was a research area that the Marine Corps Study Advisory Committee specifically asked us to address. We appreciate the fact that the Advisory Committee, when it assigned this task, also recognized the complexities involved in such an effort.

Methodologies, Findings, Conclusions and End Product. Methodologies in this Research Area have been varied. The initial literature review was followed by consultations with those presumed to be experts in combat simulations, the varieties of combat tasks, and performance of military personnel in combat situations. Although many contacts were made in the latter explorations, most of the "experts" reported they were still trying to discover an adequate and effective means of conducting what is often described as "contingency task analysis". A review was made of traditional methods that have been used to study military operations in a wartime environment. The final phase of analysis in this Research Area involved statistical studies of responses of officers in OF 02 (Intelligence) to a Task Inventory designed to provide information on tasks performed under peace time (garrison) conditions and those performed under combat (contingency) conditions.

A factor analysis of garrison and combat responses to the OF 02 inventory was among the original statistical procedures planned for this study. This had to be abandoned. The IBM 370-135 computer available to us was unable to handle what turned out to be a 2,217,768 element matrix. Alternate statistical procedures were then adopted. These included tabulation of the number of non-zero responses, calculation for each task statement of a garrison-combat index, a homogeneity index, an intensity index, and an importance index that is a composite of these, application of a computer program written to produce 8x8 matrices for each of the 614 questions, and chi squared tests of significance.

The final Technical Report for this R.A. evaluates traditional methods

of contingency task analysis. Among the traditional methods reviewed are Combat Simulation, Field War Games, Table Top War Games, Questionnaires, and Analysis of Small Unit Records of Combat Action. The discussion of each of these includes an evaluative consideration of the advantages and disadvantages in terms of feasibility, cost and practical utility. The conclusion from this phase of the study is that a questionnaire approach is probably the most feasible under peace time conditions, the least costly, and although contaminated by the possibility of faulty memories of respondents, still the method of most probable practical utility. Difficulties with this approach are recognized and evaluated, and suggestions for future research are given.

The most conventional approach to description of the contingency task environment is structured around the principal areas of concern to military commanders. Among these areas are strategy, tactics, logistics, organization, and administration. It was neither the objective of this research to explore all of these areas, nor did we have the resources to do so. The mission of Marine Corps Task Analysis is to determine what tasks Marines actually perform on their jobs within an OF. Accordingly we adopted a simpler structure in our approach to contingency task analysis. This structure is based upon the division of tasks in the combat environment into those related to man and to machines. We have followed the lead of HUMRRO in referring to this dichotomy as man-ascendant systems and machine-ascendant systems.

Task analysis of man-ascendant systems involves tasks in which human activities are paramount, and where interactions with machines are minimal or non-existent. Task analysis of machine-ascendant systems concentrates on performance of tasks in which activities are dependent upon men and machines working in concert -- with the greatest dependence being on machine performance. However, "machine-only" performance was not reviewed inasmuch as it is not considered directly pertinent to the subject of Marine Corps Task Analysis -- the study of tasks Marines actually perform. On the other hand, those tasks in which Marines guide, control, operate or repair machines are integral parts of Marine Corps Task Analysis and are considered to be machine ascendant.

The determination of skills possessed by Marines in the machine-ascendant tasks in a combat environment is more difficult than obtaining or testing their knowledge of machine-ascendant tasks and machine operations under combat conditions. And, appraising performance in man-ascendant and machine-ascendant tasks in a combat operational environment is the most difficult. However, task analysis is concerned with actual tasks performed, and these must be the focus of attention in contingency task analysis. In studying man-ascendant tasks and machine-ascendant tasks in the combat environment, obtaining reliable data about tasks performed appears to be more difficult for man-ascendant than for machine-ascendant tasks. The operations of machines possess parameters that may be fairly readily delimited for a wide range of operating environments. The same is not true for man. Contingency situations elicit expedient human responses, and task analysis as now conducted makes no provision for this.

Our original study plan proposed analyses of a number of combat scenarios as an alternative or supplement to task analysis in describing tasks performed in combat. This had to be abandoned. All scenarios with true substance carry a high security classification. None of our staff had currently valid security clearances at the level required for review of substantive scenarios. As a result, the Marine Corps Study Advisory Committee recommended that we concentrate our efforts on analyses of the OF 02 task analysis results within the time and resources remaining. This was done.

Analyses of the OF 02 task analysis questionnaire involved the major statistical studies in this Research Area. A variety of statistical procedures were used to analyze responses of a representative sample of 220 Intelligence Officers to the 614 task statements in the inventory. This questionnaire was developed by CMU at the request of our staff as part of an experiment to determine those tasks Marines perform under garrison conditions and which of these were also performed under combat conditions. In addition, specific combat tasks were included to learn whether or not similar tasks are performed in peace-time. Our analyses included evaluation of those tasks classified as "man-ascendant" and "machine-ascendant". Perhaps because of the nature of a Marine Intelligence Officer's duties, only a fraction of the questions were found to be machine-ascendant.

Results of analyses of the OF 02 data would probably have been more definitive had the size of the officer sample been larger and if the questionnaire had included fewer items. Although 220 officers completed the questionnaire, only the responses of 116 could be subjected to statistical analyses comparing garrison and combat duties. The greatest shrinkage resulted from the large number of "non-paired" responses. These totalled 95 and represented officers who either had no combat experience, or did have combat experience but could not answer the garrison questions because they were in-between assignments and could not describe a "present job". Nine questionnaires were not usable for technical reasons. The size of the reduced sample of 116 suggests a high probability of at least 10% chance errors. It is our opinion that the probability of chance errors may have been compounded by the large number of task statements (614) among which the officers had to distribute "time spent" on each task performed.

Another factor that may have affected the findings is the level of response. A zero response means "I do not (or did not) perform the task". There were 304 of the 614 task statements to which 25% or more of the Marines gave a "non-zero" response. On the other hand, only 94 questions had 50% or more non-zero responses. It is recommended that the significance of these factors -- sample size, number of questionnaire items, and number of non-zero responses -- be evaluated by CMU through the development and administration of future task inventories designed to evaluate garrison vs combat tasks following a format similar to that of the OF 02 questionnaire.

Chi-squared tests show that responses to 403 task statements, approximately two thirds of the 614 items in the OF 02 task analysis inventory,

are significantly different than one would expect from chance. Fifty-seven are significant at the .05 level, and 346 have a probability value of .01 or beyond. Computation of additional indices of significance and "importance" suggest that a smaller number of task statements are really useful in describing differences between tasks performed under garrison and combat conditions. When consideration is given to X^2 results plus analysis of the task statements by application of the homogeneity index, the intensity index, the garrison/combat index, and the importance index, it was found that there are 97 "most important" questions in the OF 02 task analysis inventory.

The Technical Report describing studies in this Research Area includes tables showing X^2 results for significant questions as well as tables giving values for each of the indices referred to above for task statements found to be significant by X^2 tests. In addition, task statements found to be significant by X^2 are listed, as are the "most important" task statements (determined by combining X^2 results with the index numbers), and several samples of the 8x8 matrices are reproduced in the Appendix.

Conclusions from studies in this R.A. are recorded in the Technical Report, but are too numerous for listing here. The most important are:

Task Analysis Inventories are the most practical and economical means of obtaining data about "contingency tasks".

More research is needed using larger samples than those in the OF 02 study. It is our opinion that CMU has the expertise within its own staff to conduct further research in this important area.

Task analysis must concern itself with both man-ascendant and machine-ascendant tasks. It must evaluate the high degree of interrelationship between men and machines in terms of the contingency environment.

Using task analysis methods that rely on memory of performance increases chances for error. Objective measures should be developed to evaluate the reliability of responses.

Statistical analysis of the OF 02 task analysis inventory was not as thorough as is needed for a truly intensive and extensive evaluation of results. A more thorough analysis would have included both a cluster analysis and a factor analysis of the data. We were unable to do this. However, CMU has the CODAP programs for cluster analysis, and it is believed it has access to the computer capacity necessary to conduct a factor analysis.

The garrison/combat index shows that task statements in the OF 02 questionnaire were more heavily oriented to garrison tasks than to combat activities. Future task analysis inventories designed

to study peace-time vs war-time activities should include a higher proportion of contingency task statements.

The overlap between the chi-squared significant questions designated 97 questions as the most important of the 614 in the inventory. This "important" group of questions falls into 11 subject or task area clusters. These questions, for the most part, are oriented to combat responsibilities, and they appear to be the most useful in determining what a Marine actually does in combat.

A number of recommendations for further research are given in the Technical Report for this R.A. Several of these are considered of sufficient significance to be included in this summary Final Report. They are:

CMU should conduct statistical analyses of the OF 02 data beyond those done in this study. These should include factor and cluster analyses to isolate task sets as a function of combat and garrison duties. Cross correlations should also be calculated among task statements and background data such as age, paygrade, education, length of service and MOS.

Additional task analysis inventories for other OFs should be developed by CMU following the garrison/combat structure used in the OF 02 inventory. These questionnaires should include more task statements that emphasize use of equipment, and they should also be either equally balanced between garrison and combat tasks, or preferably, have a higher proportion of combat task statements.

Future studies of contingency tasks should be conducted with a sample size that is sufficienty large to permit generalization to the universe of combat experience, and the sample should be representative of a cross section of combat experience.

Inasmuch as task analysis studies of contingency tasks rely upon memory of combat, objective measures of combat performances should be utilized in statistical analyses of results.

Task analysis questionnaires should be constructed on the basis of specific hypotheses CMU would like to have tested in the study of contingency tasks.

The end-product for this Research Area is Technical Report No. 12, Peace-Time Task Analysis and Its Relation to War-Time Conditions.

H. Research Area 8. The Use of Worker Characteristics in Classification and Assignment.

Traditional job analysis has included the assessment of worker characteristics as an integral part of its methodology for many years.

It was therefore logical for the Marine Corps to include the study of worker characteristics in its original Task Analysis Program. However, results obtained through task analysis inventories were suspect. They were based upon self reports by incumbents of occupational fields being studied. Assessments of worker characteristics were not obtained from observation and analysis by professionally trained job analysts or from the results of objective psychological tests. These were among the reasons that led OMU to discard worker characteristic items from its inventories at about the time this study was initiated. Another reason was the fact that no way had been found to utilize the data obtained about worker characteristics from task inventory administrations.

The Marine Corps Study Directive for Evaluation of the Task Analysis Program included the exploration of worker characteristics in classification and assignment as one of its objectives. This objective was also included in the project proposal for this research. It was not included in the first project Study Plan submitted in August, 1974 because our preliminary investigations led us to believe that the reasons for eliminating worker characteristics studies from the TA Program were still valid. We assumed, and apparently incorrectly, that Marine Corps policy about this phase of the mission of OMU had changed since preparation of the Study Directive.

Inasmuch as the Marine Corps Study Advisory Committee requested that we address the problem of collection and utilization of worker characteristics data as part of the Task Analysis Program, we included it as a separate research area in our study.

Information about worker characteristics required for performance of a job is essential in developing job specifications and for effective selection and placement. However, a number of questions must be answered before a decision is made to assign the assessment of such characteristics to the OMU staff. Studies in this research area were designed to seek answers to these questions.

After receiving this assignment from the Study Advisory Committee, our further reviews of data collected by earlier inventories convinced us that self reports by Marines about worker characteristics required for their MOS were not the answer when consideration is given to the lack of training of most Marines in making such assessments. We found that we were faced with a number of questions.

Should OMU develop a staff that is professionally trained in the assessment of worker characteristics required for effective performance in a given OF? Or, can specific standards be set in certain areas such as GED, physical demands, and perhaps temperament, so that less well trained personnel can make reliable and valid assessments when provided with specific guidelines? Can members of Task Analysis Teams validly assess the aptitudes required for effective job performance? Is this an area in which OMU should be involved, or, is this a task for

psychologists in the personnel research branch who are concerned with development, selection and validation of psychological tests?

If reliable and valid data are obtained, what steps are needed to ensure effective implementation and application in classification and assignment? How should CMC coordinate its efforts with those in personnel research and with the Marine Corps personnel who actually make classification and assignment decisions? These questions were addressed in this area of our research.

The specific objective of this research area was to explore the possibilities of acquiring greater benefit in the areas of classification and assignment utilizing data collected on worker characteristics.

Methodologies, Findings, Conclusions and End Product. Worker characteristic lists included in earlier task inventories were assembled and reviewed. Data were also obtained listing the actual ratings of importance of worker characteristics by Marines in one low technology OF and in an OF of relatively high technology. Intercorrelations among all of the worker characteristics ratings were computed. Also calculated were intercorrelations among tests in the MC Aptitude Area Classification Battery, as well as intercorrelations between aptitude test scores of a sample of Marines and the Marines' ratings of the importance of worker characteristics in task inventories for the two OFs. These studies involved the computation of over 5,100 correlations. Search was made to locate the results of studies of the validity of MC aptitude tests in relation to other means of evaluating worker characteristics. In the course of our search we learned that studies of the validity of MC and Navy aptitude tests in relation to criteria of success in service schools were underway at the Navy Personnel Research and Development Center in San Diego. We received excellent cooperation from the Center and obtained a large set of correlations among various test combinations and ratings of performance in service school training. We conducted analytical studies of these data. Alternate methods of rating worker characteristics were evaluated and one system was found that appears promising.

Computer studies of worker characteristics revealed a large number of relatively high intercorrelations among the items on the list included in earlier task inventories. In addition, many of the tests in the MC Aptitude Test Battery were found to correlate at a fairly high level with relatively high statistical significance. On the other hand, correlations among the aptitude test scores and ratings of importance of worker characteristics are uniformly low and only a few approach the .05 level of confidence.

Evaluations of ratings of the importance of worker characteristics by Marines in the two OFs studied appear to be logically inconsistent in that Marines in the low technology OF consistently rated all of the worker characteristics as being of greater importance for performance of duties in their OF than did Marines in the high technology OF.

These correlational and comparative studies have led to the conclusion that when worker characteristics data are gathered by means other than objective aptitude tests, estimates of required characteristics for a given OF can best be made by analysts who are trained in observation and interview methods for appraising such characteristics.

Analyses of the validity coefficients of test batteries presently used for predicting success in service school training revealed some disturbing surprises. These analyses were based upon data received from NPRDC, San Diego. The validities of test combinations now used as one of the criteria for selection of enlisted Marines for service schools are lower in more than half of the test batteries in use for this purpose than are other test combinations. Improvements in validity coefficients by using different combinations of tests than now in use range from .05 to as high as .35. In many of the schools where improvements in validities can be made, the improved validities could be achieved by using an entirely different combination of aptitude tests than those included in test batteries presently used for selection of Marines for attendance at these schools. In some instances it was found that the addition of only one other test to a current test battery would provide marked improvement in prediction of success in training. In some cases it was found that use of only one aptitude test was more efficient than the full test battery now employed.

Findings of such widespread disparities among service school selection batteries and training performance led us to investigate the basis for establishment of these selection standards. We found that the most recent research on Marine Corps' selection test batteries was conducted in 1963. We have been unable to find any studies between that date and those recently conducted at NPRDC, San Diego within the last year.

The 1963 studies were commissioned by the Marine Corps and conducted by H.A. Edgerton. Edgerton's studies were based upon a classification test battery made up of eleven tests obtained from the Army. It was hypothesized that the similarity between many Marine Corps and Army jobs permitted direct utilization of the Army tests for Marine Corps purposes. However, it was found that some differences between Army and MC jobs did exist, and effectiveness of the tests was therefore evaluated exclusively in terms of Marine Corps experience.

In Edgerton's research, the records of Marines attending several service schools, and Marines in selected non-schooled MOS's, were reviewed and analyzed. A similar analysis was conducted for Aviation MOS's. This research resulted in identification of several aptitude-areas based upon test combinations that yielded the highest correlations between an aptitude area and a given group of Marine Corps jobs. These standards have remained in effect continuously since 1963. We have been unable to find any evidence of cross-validation studies or revalidation studies since that time until the recent correlational studies conducted by NPRDC, San Diego.

We were recently informed that the Marine Corps Operations Analysis Group (MCOAG) conducted some preliminary studies during 1975 of the relationships among a number of variables and the training school performance of enlisted Marines. We requested data from these studies but

were advised that due to the preliminary nature of the research, no results would be released until further studies had been completed. We are therefore unable to comment about any relationships between findings of these studies and those conducted by NPRDC, San Diego during the same time span. However, the extent of the research undertaken by both MCOAG and NPRDC within the last year and a half suggests that there may be a growing recognition within the HQMC of the importance of personnel research to maintenance of the effectiveness of the Marine Corps in accomplishment of its mission.

As noted earlier, many of the test batteries now in use as one of the criteria for selection of Marines for Marine and Navy service schools have considerably less effective validities than other test combinations. It is our recommendation that results of the research conducted at the NPRDC, San Diego be used as the basis for establishing new test batteries for service school selection in those cases where different test combinations have been demonstrated to have higher validities than those now in use.

We have been told that the Armed Services Vocational Aptitude Battery (ASVAB) will soon be the standard selection and placement battery for all armed services including the Marines. Budgets should be planned now for validating the ASVAB in relation to service school training performance. And, even more importantly, job performance standards for each MOS need to be developed and then correlated with ASVAB test scores in order to ensure placement of recruits in the most suitable MOS's in relation to their aptitudes.

It is recommended that the Marine Corps conduct periodic validity studies of its aptitude tests in every area in which they are used as part of a decision-making process. Selection standards must be continuously reviewed, using rigorous research methodologies, if they are to continue to be effective. As conditions change, standards must be changed. Changes in conditions, whether these are changes in instructional methods, changes in methods of evaluating performance, or changes in technology, as well as changes in the nature of new Marine Corps recruits, can all affect validities of tests and test batteries obtained under different conditions and with different populations. The Marine Corps needs to develop means to identify and measure the effects of these changes and to take action accordingly.

Our studies suggest that the Marine Corps has not provided full support to personnel research activities. This appears to have been especially true for the years between 1963 and 1975. Sound research is needed to develop selection and placement procedures that will effectively improve the identification of civilians who will be the best recruits and the Marine recruits who are best suited for training in OF's requiring special aptitudes. We recommend substantially stronger support from HQMC for the personnel research function. This is considered essential to ensure that the Marine Corps' traditional standards of excellence are maintained, and that fulfillment of its mission will continue through improved methods of identifying for recruitment the men and women who possess the qualities needed to meet the high standards of Marine Corps service.

Our studies reviewed several methods of gathering data on worker characteristics as possible alternatives to the Worker Characteristics Scale included in earlier Marine Corps Task Inventories. We have concluded from these studies that OMJ's decision to eliminate the scale from its inventories was a wise one. This scale was a mixture of evaluations of physical characteristics, psychomotor abilities, mental capacities, and other factors as varied as adaptability, emotional stability, initiative, and moral courage. In application of the discontinued scale, Marines with no training in assessment of worker characteristics were asked to evaluate the importance of such characteristics in the performance of duties in their MOS. Psychomotor abilities and mental capacities are much better measured by objective tests no matter how well trained are the analyst-observers. In the use of any such future scale, it is recommended that only physical characteristics not readily measurable by objective tests, and perhaps special environmental conditions affecting performance, be included. It is also recommended that, instead of depending upon Marines untrained in assessing such factors, only Marines trained in methods of evaluating worker characteristics be assigned to make such assessments.

Most check-lists for evaluating worker characteristics use such terms as occasionally, moderate, frequently, light, heavy, etc. as descriptive terms. All too often these terms are not clearly and specifically defined. Raters assessing these characteristics often must use their own criteria of what is light, moderate and heavy, and judgments between raters frequently vary because each has his own idea of what is light and heavy. Most methods also do not indicate how often such factors as light or heavy lifting are required on a job in a normal work day.

Our review of the literature revealed only one method that we feel meets our criteria for evaluation of physical and environmental demands of a job and the characteristics of individual Marines required to meet these demands. It meets many of the requirements of a good measuring device: it has a unit, a zero, and criteria. It presents measured judgments in such specific form that the analyst is not left in doubt -- he does not have to depend upon his own subjective criteria. It also allows for error, but on the safe side. This system has been called the "specific method" by its developer, Hanman. (His book on the specific method is listed in the bibliography.) The method was developed to provide a more precise system for assessing the demands of a job, and at the same time, provide a more definitive method for evaluating the physical capacities of a disabled individual in relation to the job or jobs for which he is being considered. Ratings of an individual's capacities were made by a physician in the context of Hanman's studies. Ratings of job requirements were done by trained analysts. Although originally developed to aid in the appropriate placement of disabled persons, Hanman's specific method is equally applicable to assessment of worker characteristics of non-disabled individuals in relation to the physical and environmental demands of a job.

It is our conclusion that Hanman's specific method can be used in the Marine Corps to improve classification and assignment. With the advent

of an all-volunteer armed force, and with EEOC pressures for the acceptance of more women and members of minority groups into the military services, the need for objective assessment of individual worker characteristics in relation to physical and environmental demands of jobs in our military services (as well as valid measurement of aptitudes by tests) has become much more critical than it had been viewed under earlier conditions.

Hamman's specific method is described with explicit guidelines for application in the final technical report for this Research Area. It is recommended that this method be considered for use in evaluation of the physical and environmental demands of appropriate jobs within Marine Corps Occupational Fields. It is our opinion that OMU is in an ideal position to gather such data as a part of the Observation and Interview phase of its TA studies of OFs. Assessments should only be made by OMU Task Analysts who have been trained in use of the specific method. Coordination of use of the data gathered by OMU about physical and environmental demands of Marine Corps jobs is necessary, provided decision is made by the Marine Corps to follow our recommendations. Marine Corps medical personnel should be trained in use of the specific method in evaluating physical capacities of individual Marines in relation to job demands. Data about job demands and the capacities of individual Marines to meet these demands must be provided to the Marine Corps Monitors who make selection and placement decisions. This is considered essential to the effectiveness of the Monitors' decisions in attempting to match the individual Marine's classification and assignment with the requirements of jobs for which he is being considered.

End-product for this Research Area is Technical Report No. 13, Worker Characteristics in Marine Corps Task Analysis.

A Note on Studies of Job Satisfaction.

A brief job satisfaction questionnaire has been included as a part of Marine Corps task inventories for several years. The MC Study Directive authorizing this research project (see Appendix B), listed job satisfaction as a topic to be addressed in the study. Accordingly, studies of job satisfaction were initiated and were included in our original Study Plan.

When the Marine Corps Study Advisory Committee requested restructuring of our Study Plan in the latter part of 1974, it also deleted three of the nine Research Areas we had proposed and substituted two others of more direct interest to the Marine Corps at that time. The studies of job satisfaction and causes of dissatisfaction were in one of the Research Areas deleted by the Study Advisory Committee as topics the Committee considered could be resolved by in-house research.

Although not "officially" a part of our research because of modi-

fication of the Study Directive by the Committee, we feel that a few observations about our initial investigations in the area of OMU's job satisfaction studies are appropriate in concluding this discussion of Research Areas officially addressed.

We have been impressed by OMU's research into Marines' attitudes about those factors in their jobs that lead to satisfaction or dissatisfaction. This research has not been static. Statistical and other analytical studies by OMU over a period of several years have resulted in modifications in content, question phrasing and response categories in job satisfaction questionnaires. Changes that have been made have been based upon sound research and have resulted in improvements. However, we could find little evidence that the data collected have been utilized to any extent by the Marine Corps.

It has been our observation that most members of the HQMC staff who have been presented with data concerning job satisfaction/dissatisfaction of Marines in different OF's have shown what might be described as a "ho-hum" attitude. There has seemed to be little, if any, concern about how Marines feel about their jobs and how they feel about a long term career as a Marine. We have found this difficult to understand, especially in view of the incentives provided by all armed services to encourage reenlistments.

It is our opinion that information indicating how Marines feel about their jobs, their supervisors, their chances for advancement, and about making a career of Marine Corps service should be of special concern to Marine Corps policy-makers and to HQ level personnel responsible for the classification and assignment of Marines. It is our recommendation that results of job satisfaction questionnaires in each task inventory administered by OMU be provided, as a minimum, to the appropriate OF Sponsors, the Director of the Manpower Planning and Policy Division, and to the Commandant's Deputy Chief of Staff for Manpower. A wider distribution may be desirable so that positive actions based upon job satisfaction findings can be taken at several different organizational levels. The Director of OMU may be in a position to make recommendations for such a distribution to the DC/S Manpower, HQMC.

IV

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Detailed conclusions from this research are included in many of the project Technical Reports. Most of these conclusions have been discussed in the reviews of the eight Research Areas summarized in this final report. Because of this, they are not repeated again in this terminal section. However, one over-all conclusion has not been recorded elsewhere. It deserves mention here.

The over-all conclusion from our research is that the Marine Corps Task Analysis Program is a highly valuable asset to the Marine Corps in improving and maintaining effective utilization of its human resources. OMU, in spite of its austere budget and limited staff, has produced a high return on the investment that the Marine Corps has made in this organization. The Commandant's initiative, foresight, and good judgment in establishing the Task Analysis Program have been repaid many times over by the cost savings, cost avoidance, more efficient structuring of OF's, more effective use of training resources, and the improvements in morale that have resulted.

One conclusion that is recorded in the body of this report is considered to be of such special significance that it merits repetition in this final section. It is summarized in the following paragraph.

An important contributing factor to success of the TA program has been the assignment to the OMU staff of top quality, highly competent and appropriately trained officers. Similar standards in the selection and assignment of officers and SNCOs to OMU must be maintained if the Marine Corps is to reap the same benefits from the TA program in the future that it has gained in the past.

Recommendations

The majority of project Technical Reports contain a number of recommendations for action by OMU, and in some cases, by higher levels of command in Headquarters, U.S. Marine Corps (HQMC). Inasmuch as each Technical Report deals with no more than one Research Area, background data supporting the recommendations are more complete in those reports than is feasible in a summary such as this Final Report that attempts to cover all eight Research Areas. In addition, recommendations in several of the reports are accompanied by specific suggestions for their implementation. It is not the intent of this report to provide details of this nature.

This terminal section summarizes the major recommendations in the series of technical reports that are the primary end-products of

our research. Each recommendation listed below is keyed to the text of this report by page number or refers to the appropriate Technical Report for more background information. As noted in the text, some of the recommendations have already been implemented by OMU. These are included at the request of the Marine Corps Study Advisory Committee "in the interest of completeness".

It is our opinion that OMU has the capabilities and resources to implement these recommendations with little or no cost to the Marine Corps. Our recommendations are intended further to improve the already high level of effectiveness of the Marine Corps TA program. We are hopeful that HQMC will have sufficient interest in them to give our recommendations favorable consideration. Following is a summary of the major recommendations resulting from our research.

- The traditional OJT approach for orientation to the TA program of Officers and NCOs newly assigned to OMU needs to be supplemented by a more formal orientation and training program that will reduce training time and help new personnel become effective contributors to the TA program early in their tour of duty at OMU. (Page 9)

- Thorough reviews of training manuals and other documents and sources describing tasks in an OF should be made during the Study Phase, and preliminary task statements prepared at that time. Statements thus prepared should then be reviewed with sponsors, monitors, service school instructors, and other "experts" in the OF. The accuracy of these task statements could then be validated or corrected at the same time that data on tasks not disclosed by the preliminary studies are obtained through observation and interview visits to a cross-section of Marine Corps facilities. (Page 10)

- OMU should eliminate the two-booklet format for task inventories and either change to a one-booklet format with separate answer sheets or to a single booklet containing spaces for responses adjacent to each item in the booklet. (Page 11)

- In changing to a one-booklet task inventory format, OMU should investigate alternatives to the OCR system of recording responses that has not been fully satisfactory. (Page 11)

- In order to reduce the time required for Marines to complete a lengthy task inventory, OMU should experiment with division of task statements in an inventory into a series of booklets containing fewer than the total number of task statements in the total questionnaire. Sufficient overlap of task statements in several booklets must be made so that an adequate sample of responses to each task statement in the complete inventory is obtained. (Page 14)

- Careful attention to wording of task statements needs to be given to ensure understanding by respondents in an OF. (Page 15)

- Periodic evaluation of the readability level of task inventories should be made, and attitude surveys should be conducted on a sampling basis to assess the reactions of Marines to future task inventories. (Pages 15 & 16)

- In administering task inventories, OMU should select a representative random sample of 400 Marines in each OF studied by the TA process. This should be a minimum. And, our studies indicate that if a truly representative sample is drawn, an N of 400 is adequate as a maximum provided a confidence level of .05 is considered acceptable. (Pages 16 & 17)

- OMU should conduct an independent experiment of its own if it wishes to determine the effects upon clustering of a sample size of 400. This can be done by drawing a random sample of N=400 (by means of a random number generator) from an OF in which a much larger number of Marines completed task inventories. Analysis of CODAP results will indicate whether the clustering program produces the same job types for the sample of 400 as for those in the total sample. (Technical Report No. 11)

- Our finding that eliminating overseas sampling does not affect task analysis results should be further tested by OMU in several different OF's. This should first involve application of statistical methods similar to those used in our research. OMU should then study the effect upon clustering resulting from elimination of overseas sampling. (Pages 17 & 18)

- The use of CODAP programs should be continued. In addition, efforts should be made to adapt more programs in the CODAP "package" to the computer facilities available to OMU. (Page 19)

- OMU should perform two cluster analyses for each OF study. One should include task statements covering both the military or "general" tasks that Marines perform and those tasks that are specific to the OF. The other should be conducted with all general military tasks excluded. Results of the two analyses should be compared before decisions are made about job categories within the OF. (Pages 19 & 20)

- Research by OMU on different ranges in response scales, e.g. five vs. eight, should be considered. Studies of this type might result in a scale that would provide more accurate data on "time-spent" on OF tasks. (Page 20)

- OMU should consider changing its organizational structure from its traditional independent TA team concept to a more functional type of organization. The modification should be designed to provide for more flexibility than the traditional structure and for specialization of staff in such areas as

computer programming, data analysis, and report writing. (Pages 21 & 22)

- The Director of OMU should be given the opportunity to review the service records of SNCOs proposed for assignment to the OMU staff and be a direct participant with the monitor in their selection. He should also have the right of veto. (Pages 22 & 23)

- OMU should consider the application of PERT to one or more OF studies following procedures outlined in Technical Report No. 3. It may also be desirable to plot the major events for several OF studies on a single PERT-type chart to facilitate planning, scheduling, coordination and control when several TA studies are in process at the same time. (Page 23)

- As part of its training program to improve communication and cooperation among members of the OMU staff, problem-solving seminars similar to the demonstration seminar conducted by Cal State L.A. staff members should be conducted periodically. (Page 24)

- More formal training procedures than have existed in the past need to be instituted by OMU -- especially for newly assigned staff members. Plans should be made for the full utilization of the five Training Manuals prepared by the research staff. Other Technical Reports should be made readily available to all staff members as part of an on-going training program. (Page 25)

- Although referred to in Technical Report No. 6, but not specifically stated in this Final Report, OMU should designate a Training Officer from within its staff. The Training Officer should be assigned specific responsibilities for planning and coordinating staff training and for ensuring that training plans are effectively implemented. (T.R. No. 6)

- OMU should develop and administer additional task inventories designed to evaluate garrison and combat tasks following a format similar to the OF 02 officer inventory. Data from these admininistrations should be used to test the significance of the factors that appear to have affected findings in the OF 02 study -- sample size, the number of questionnaire items, and the number of zero and non-zero responses. (Page 28)

- Future task inventories designed to study "contingency tasks" should include more task statements that emphasize the use of equipment. They also should be either equally balanced between garrison and combat tasks, or preferably, have a higher proportion of combat task statements. (Page 30)

- OMU should conduct statistical analyses of the OF 02 data beyond

those done in this study. These should include factor analysis and cluster analysis to isolate task sets as a function of garrison and combat duties, as well as correlations among task statements and background data such as age, paygrade, education, length of service and MOS. (Page 30)

- Inasmuch as task analysis studies of contingency tasks rely upon memory of combat, objective measures of combat performances should be utilized in statistical analyses of results whenever possible. (Page 30)

- Results of the test validity research conducted at NPRDC, San Diego should be used as a basis for establishing new test batteries for service school selection in those cases where different test combinations have been demonstrated to have higher validities than those now in use. (Page 34)

- Plans should be made now for validating the ASVAB in relation to service school performance as soon as the new test battery replaces the aptitude tests now in use by the Marine Corps. (Page 34)

- Job performance standards need to be developed and then correlated with ASVAB test scores in order to ensure placement of recruits in the most suitable MOS's in relation to their aptitudes. (Page 34)

- The Marine Corps should conduct periodic validity studies of its aptitude tests in every area in which they are used as part of a decision-making process. Research of this nature is considered essential to maintain effective test utility under changing conditions and changing recruit populations. (Page 34)

- Strong and continuing support for the personnel research function must be provided by HQMC to ensure that the traditional excellence of the Marine Corps is maintained. Research can contribute to that excellence by developing effective selection and placement standards that can identify the "good" man and women who have the qualities to meet the desired standards for a Marine recruit and for a specialist in a critical OF. (Page 34)

- CMU should experiment with the use of Hannan's "specific method" for evaluation of the physical and environmental demands of appropriate jobs within Marine Corps OF's. (Page 36)

- Assessments of worker characteristics reflecting physical and environmental demands should be made only by analysts who

have been trained in the specific method or in such other method of appraising worker characteristics as the Marine Corps selects. (Pages 33, 35 & 36)

- Marine Corps Medical Officers should be trained in the use of Hamman's method and be responsible for the evaluation of worker characteristics of individual Marines in relation to job demands in different OF's. (Page 36)

- Data about job demands and the capacities of individual Marines to meet these demands must be provided to the MC Monitors who make selection and placement decisions if the Marine Corps decides to use the specific method in the measurement and use of worker characteristics, as we recommend. (Page 36)

- The results of job satisfaction questionnaires included as part of each task inventory administered by CMU should be provided, as a minimum, to the appropriate OF sponsors, the Director of the Manpower Planning and Policy Division, and to the Commandant's Deputy Chief of Staff for Manpower. A wider distribution is considered desirable, but this appears to us to be an area of decision for HQMC as to whether or not it is important that Marines be satisfied with their careers as members of the Corps. (Pages 36 & 37)

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APPENDIX A

ANNOTATED LIST OF

PROJECT TECHNICAL REPORTS

ANNOTATED LIST OF

PROJECT TECHNICAL REPORTS

Farrell, William T., HIERARCHICAL CLUSTERING: A BIBLIOGRAPHY, Technical Report No. 1, July, 1975.

Cluster analysis in the Task Analysis process is a statistical methodology using algorithms to produce hierarchies that isolate groups of tasks that, because of their relationships, form separate jobs. It may perhaps be decribed as the central statistical technique for analyzing task analysis data in studies of Occupational Fields by the Marine Corps, the Air Force and other military services. As part of the research in Evaluation of the Marine Corps Task Analysis Program, a thorough search of the literature was conducted to discover published sources describing hierarchical clustering and related methods of classification analysis. This 184 item bibliography is a result of the search. The majority of references were published within the last ten years. This compilation is considered to be a relatively comprehensive and representative bibliography of articles and books that were produced in that time span, plus a few older references that were deemed relevant to the research project. The Bibliography is not annotated. One article listed in the Bibliography was selected for reprinting in its entirety as a part of this Technical Report. It is the opinion of the author that the article could be of special value to the Marine Corps Office of Manpower Utilization for use in orienting new members of the Task Analysis staff to principles of classification and cluster analysis. The article, "Classification: Purposes, Principles, Progress, Prospects", by Robert R. Sokal was published in the September 27, 1974 issue of Science, Vol. 185, No. 4157, PP 1115-1123. This scholarly article is clearly written in language that for the most part avoids scientific jargon, and when scientific terms are used, they are explained.

Kuriloff, Arthur H., Yoder, Dale, and Stone, C. Harold, TRAINING GUIDE FOR OBSERVATION AND INTERVIEWING IN MARINE CORPS TASK ANALYSIS, Training Manual III, Technical Report No. 2, August, 1975.

This Training Guide has been developed for use by staff members of the Office of Manpower Utilization (OMU), HQMC in their preparation for Task Analysis projects. It is designed to provide basic orientation to Task Analysis and detailed suggestions for carrying out the entire observation and interview phase of the Task Analysis process. Various types of job analysis are described in terms of the most common methods and their advantages and limitations. Special attention is directed to requirements of reliability and validity in the collection of TA data, and to recommended procedures for meeting these requirements. To ensure the quality of findings in Task Analysis studies of Marine Corps Occupational Fields, specific recommendations are given for all major steps in the data-gathering process including improving interviews by checking questions, building respondent motivation, developing listening ability, managing the interview, and improving both observation and the recording of information.

Hemphill, John M., Jr., Stone, C. Harold, and Yoder, Dale, PROGRAM EVALUATION AND REVIEW TECHNIQUE (PERT): A PLANNING AND CONTROL TOOL FOR OCCUPATIONAL FIELD STUDIES, Technical Report No. 3, September, 1975.

PERT is a management tool that makes possible more accurate, more objective, and more rapid planning and control of a complex project. Applied research by the ONR-USMC Task Analysis project staff indicated that a full description of PERT and its applications to Occupational Field (OF) studies would be of operational value to the Office of Manpower Utilization (OMU), HQMC. This was based upon the fact that an OF study in the Marine Corps Task Analysis Program is a project that involves completing specific study steps in a logical sequence. Several identifiable activities or tasks are performed over a period of time to complete each study step. A need was seen for a plan to implement the study project and a technique for controlling it throughout. PERT can be useful in developing a detailed implementation plan -- including scheduling work, estimating time requirements, determining staffing needs, and pin-pointing check points for reports on and control of an OF Task Analysis study. This report on PERT is designed to serve two purposes. First, it can be used as training material for new personnel to introduce them to techniques of planning and control in OF studies. Second, it can provide ready reference materials for individuals directly involved in designing, directing, planning, and controlling OF studies. The description of PERT in this report is specifically addressed to Task Analysis as conducted by the Marine Corps. Accordingly, the various steps, events and activities used as illustrations in the application of PERT employ the terminology of the different phases of OMU's Task Analysis process. However, the same principles can be applied in the planning, tracking and control of any project. This is a detailed description of the use of PERT and the steps involved in developing a usable PERT network. Major sections of the report cover: Operational aspects of PERT use in OMU; How to develop a PERT schedule; Time estimates; Completing the PERT schedule; Managing Occupational Field studies with PERT.

Farrell, William T., Stone, C. Harold, and Yoder, Dale, GUIDELINES FOR RESEARCH PLANNING AND DESIGN IN TASK ANALYSIS, Technical Report No. 4, September, 1975.

This report focuses upon Task Analysis as research. It is based upon the fact that the Task Analysis program conducted by the Office of Manpower Utilization, HQ, USMC (OMU) involves purposive, systematic investigations and analyses in order to prepare reports of findings that will be useful and influential in Marine Corps planning, policy determination, and management. Guidelines are presented for the planning and design of OMU's projects so that they will justify proper respect and credibility and thereby achieve maximum impact and value. Principles and procedures are outlined so that each Task Analysis project can be planned, designed and conducted in a manner consistent with recognized criteria of dependable scientific research. In addition to the focus upon the research nature of Task Analysis, the qualities of the researcher himself, and his influence upon the research are discussed.

The main emphasis of the report is upon research planning and design. The main topics are: Statement of the research problem -- hypotheses; Contribution to theory; Operationalizing the research; Determining sample size; Collecting the data; Analyzing the data, with emphasis upon cluster analysis; and, The research report.

Hemphill, John M., Jr., and Yoder, Dale, MANAGEMENT AUDITING, Technical Report No. 5, September, 1975.

The Management Audit is described for possible application as an extension of the mission of the Office of Manpower Utilization (OMU), HQMC. The present mission of OMU is viewed as a manpower research program to conduct Task Analyses of Marine Corps Occupational Fields. Purpose of the analyses is to improve the functional areas of classification, assignment, training, grade and MOS structure, job requirements, and job validation. Major topics in this report are purpose and scope of management auditing, overview of the management audit process, comparison of the management audit with task analysis, and implications of the management audit approach for OMU. Annotations of significant references on management auditing are included in a selected bibliography.

Yoder, Dale, Hemphill, John M., Jr., and Stone, C. Harold, OMU ORGANIZATION AND PERSONNEL, Technical Report No. 6, October, 1975.

The basic mission of the Office of Manpower Utilization, HQMC, (OMU) is to conduct task analyses of Marine Corps Occupational Fields. In its desire to maximize its effectiveness, OMU requested an independent evaluation of its program. This report summarizes studies and results of part of that evaluation, Research Area 5, "OMU Organization and Personnel", one of eight Research Areas into which the study was divided. The basic tasks of Research Area 5 were to discover, describe and evaluate OMU policies and procedures relative to organization, task analysis team assignment and structure, and team member procurement; identify indications of less than optimal performance and alleged deficiencies; design and evaluate experimental alternatives and/or modifications; summarize problem areas and report findings from experiments; identify and evaluate options in change and prepare recommendations for action. The research was not conducted in a static situation. Feedback to OMU was provided by the research staff as findings were made. Direct actions often were initiated by OMU immediately, and OMU thus represented a "moving target" during the course of the study. This report is a frank discussion of methods and phases of the study, findings, changes that occurred during the study and recommendations for future actions. Organizational structures at the beginning and the end of the research are shown. One problem was still not resolved by the end of this study. Some NCOs assigned for duty with OMU do not possess the qualifications required for effective performance in the highly specialized tasks they are expected to perform. It is recommended that OMU be involved in the review of qualifications of NCOs being considered for assignment to its staff before assignment decisions are made.

Kuriloff, Arthur H., PRINCIPLES OF TRAINING IN MARINE CORPS TASK ANALYSIS, Training Manual I, Technical Report No. 7, December, 1975.

This training manual is designed to be used by Marine Corps personnel responsible for training Task Analysis (TA) specialists. This is the first of a set of five training manuals that contain recommendations and suggestions for helping members of TA teams acquire essential capabilities for training and for performing Task Analysis functions. Objectives of the set of training manuals are: 1. To recommend procedures and training materials for minimizing the time to orient and train new analyst team members; 2. To increase the period of time new members will be productive on an analyst team by shortening the indoctrination and training period; and, 3. To upgrade skills for increasing the effectiveness and productivity of experienced as well as new members. This first manual is relatively brief. It discusses individual competencies required for Task Analysis; Background in the methodology of training; Recommendations for trainee motivation; Dimensions of the training problem -- content, method, and evaluation; Skills required to support team performance in task analysis.

Kuriloff, Arthur H. and Yoder, Dale, COMMUNICATIONS IN TASK ANALYSIS, Training Manual IV, Technical Report No. 8, October, 1975.

This is the fourth in a series of five Training Manuals developed to aid the Office of Manpower Utilization, HQMC, in the training and orientation of new staff members assigned to the Task Analysis program. Effective communication is considered to be a central factor in the gathering, recording, analyzing, and reporting of task analysis data in a reliable and valid manner. Two Manuals in the series direct attention to this topic. The first is Technical Report No. 2, "Training Guide for Observation and Interviewing" (Training Manual III). The present manual deals with three areas of communication, one of which, Active Listening, may be viewed as an extension or supplement to the Training Guide for O&I. The first section reviews problems of communication within an organization or Task Analysis team that can hinder effectiveness, and it gives suggestions for improving the quality of intra-organization communication. The second chapter stresses the importance of active listening, recommendations for achieving active listening, testing for understanding, and problems in active listening. The third section is the most detailed and gives a broad range of guidelines on "How to Write Clearly". As examples, topics covered include how to outline, the rough draft, the terminal section, avoiding unnecessary words, avoiding the fault of complexity in technical writing, use of short sentences, improving readability, testing for readability, using active verbs, and selecting familiar words.

Kuriloff, Arthur H. and Yoder, Dale, TEAMWORK IN TASK ANALYSIS, Training Manual V, Technical Report No. 9, November, 1975.

Each project in the Marine Corps Task Analysis program is assigned to staff members, organized to form a work-team. Their continuing performance, as an effective team, is crucial for the success of the project. This Training Manual provides guidelines for effective teamwork and work-team maintenance and development. Chapter I, the major portion of the Manual, begins with an explanation of the major obstacles to optimal team performance and describes methods using the tool of intervention for diagnosing problems in work teams, with explanation of such specific techniques as goal-setting, action-planning, the organization mirror, force analysis, and business games. Chapter I also outlines methods and techniques for achieving organizational change and improvement, with special attention to conflict resolution, role reversal, and team development. Chapter 2 of the Manual explains "management by objectives" as an integrated system for planning and achieving effectiveness in teamwork. Chapter 3 discusses how use of the matrix organization may offer advantages as an alternative to the traditional organizational pyramid. Included is an annotated bibliography of books and other published materials dealing with organization maintenance, development, and teamwork.

Hanson, Phillip J., INTRODUCTION TO MARINE CORPS TASK ANALYSIS, Training Manual II, Technical Report No. 10, February, 1976.

This Training Manual is designed to aid in the orientation of personnel newly assigned to OMU. It provides a brief overview of Marine Corps Task Analysis (TA) as it is conducted by OMU. Basic steps in the TA process are: 1. Construct a task inventory, 2. Administer self-report inventory, 3. Analyze, using CODAP, 4. Recommend solutions to identified problems, 5. Secure approval of recommendations. The Manual gives a brief description of each step. OMU's major goal of improving the utilization of human resources in the Marine Corps is discussed, and the way the staff is organized to accomplish this is presented. Appendices provide brief definitions of TA terms and a synopsis of the Comprehensive Occupational Data Analysis Programs (CODAP) used to define jobs in an occupational field.

Farrell, William T., Yoder, Dale, and Stone, C. Harold, GUIDELINES FOR SAMPLING IN MARINE CORPS TASK ANALYSIS, Technical Report No. 11, March, 1976.

It has traditionally been the policy of OMU to administer a task analysis inventory to the largest possible sample in an occupational field. Some sample sizes appear to be in excess of statistical requirements for effective analysis, and costs for administering and processing large numbers of inventories are greater than would be incurred with more modest sample sizes. This report

discusses general conclusions from our research on optimum sample size and outlines guidelines for acceptable sampling strategy. Part I specifies and discusses three generally recognized essential requirements for the design of an optimum sample. Part II spells out major implications of these requirements as they apply to samples in TA occupational field studies and summarizes requirements for a sampling design for OMU. Part III reports findings that suggest a uniform optimum size for OMU samples, and Part IV details a recommended sampling strategy for guidance in data collection.

Hanson, Phillip J. and Stone, C. Harold, PEACE-TIME TASK ANALYSIS AND ITS RELATION TO WAR-TIME CONDITIONS, Technical Report No. 12, April, 1976.

All Marine Corps Task Analyses of occupational fields performed to date have been conducted under peace-time rather than war-time conditions. The specific objective of research in this area was to determine the type of task analysis that would be effective in measurement of tasks that are not now being performed by Marines but would be performed by them in combat (under "contingency conditions"). This report evaluates traditional methods of contingency task analysis. Among the methods reviewed are Combat Simulation, Field War Games, Table Top War Games, Questionnaires, and Analysis of Small Unit Combat Journals. The discussion of each of these includes an evaluative consideration of the advantages and disadvantages in terms of feasibility, cost and practical utility. The implications of task analysis of man-ascendant systems and machine-ascendant systems are reviewed. A major portion of the report presents results of statistical analyses of data from a task inventory designed to determine the tasks Intelligence Officers are performing now and those that they performed under combat conditions. The conclusion from our studies is that a questionnaire approach is probably the most feasible under peace time conditions, the least costly, and although contaminated by the possibility of faulty memories of respondents, still the method of most probable practical utility. Recommendations are given for construction of contingency task inventories and for further research by OMU.

Washburn, Paul V., Stone, C. Harold, Judd, Peggy A., and Farrell, William T., THE USE OF WORKER CHARACTERISTICS IN MARINE CORPS CLASSIFICATION AND ASSIGNMENT, Technical Report No. 13, May, 1976.

This report describes research that was designed to explore the possibilities of acquiring greater benefit in the areas of classification and assignment utilizing data collected on worker characteristics. Primary attention is given to measurements of physical demands and environmental conditions of jobs that are not readily measured by objective aptitude tests. Reviews are made of earlier

data collection by the Marine Corps using task inventories, and to the research of other organizations in this area. The use of aptitude tests in the Marine Corps to select Marines for specialized training in service schools is also analyzed. A major recommendation resulting from studies of aptitude tests is that the Marine Corps should place greater emphasis upon personnel research and test validation and provide more substantial support for such activities. Considerable statistical data are provided about test validities for selection of Marines for service school attendance and the relationships among earlier worker characteristics data collected by task inventories and aptitude test results. An important part of this report is devoted to a discussion of Harman's "specific method" for appraising the physical and environmental demands of jobs and assessing the physical capacities of individuals to meet these demands. The specific method is recommended for trial in the Marine Corps and instructions for its use are given in detail.

Kishi, Akemi, Judd, Peggy A., Yoder, Dale, and Stone, C. Harold, TASK INVENTORY CONSTRUCTION, Technical Report No. 14, June, 1976.

The specific objectives of research on this topic were to determine an optimum inventory size that would have equal or greater effectiveness than previous Marine Corps task inventories, and to develop procedures for the phrasing of task statements to avoid ambiguities and be understandable to as broad a range of Marines as is possible with a paper and pencil inventory. A related objective was to develop recommendations for inventory design and format. OMU has traditionally used a two-booklet format for its task inventories. One booklet contained task statements, and the other was an answer booklet. Research resulted in a single task inventory booklet that includes response categories to questions and task statements on the same page and immediately following the items. Transfer of responses to computer storage is accomplished by the key-to-disk method. The result of studies of task inventory size (some Marine Corps inventories have contained as many as 1,000 items) was a recommendation that OMU experiment with a "mini-booklet" format that would substantially reduce the number of items to which an individual Marine would be required to respond. An experimental design is given for dividing a lengthy task inventory into a series of shorter inventories. There is sufficient over-lap of task statements in each small questionnaire booklet to provide adequate samples of responses to each item. Major attention is given to the wording of task statements and task inventory instructions. Data are presented from the application of five measures of readability to nine task inventories. Reading comprehension levels of Marines at three Marine Corps bases are described and are compared with the comprehension levels required to understand task statements and instructions in task inventories. Guidelines for wording of task inventory items to improve understanding are provided. Methods for measuring readability are outlined. Also discussed are studies of the effects of anonymous versus identified responses in task inventories.

Farrell, William T., COMPUTER PROCEDURES AND DATA ANALYSIS IN MARINE COPRS TASK ANALYSIS, Technical Report No. 15

Completed Marine Corps Task Analysis (TA) inventories are processed by OMU using a number of computer related procedures designed to yield outputs that can be interpreted to support the TA process. This technical report discusses research that was designed to improve the efficiency and effectiveness of these procedures and subsequent analysis of TA data. Central to these procedures is use of the Comprehensive Occupational Data Analysis Programs (CODAP). The uses of CODAP in relation to alternate clustering methods for analyzing TA data are reviewed and conclusions presented. One section of this T.R. is designed to aid in the understanding of cluster analysis by OMU personnel not trained in the use of CODAP or other classification procedures. Special attention is given to the use of rating scales in task inventories that describe the amount of time spent on tasks. Recommendations are given for further research on this topic by OMU. The effects on cluster analysis of inclusion in task inventories of military or general duty tasks along with occupational tasks specific to an OF are examined. Examples are given that suggest inclusion of general duty tasks can create serious chances for bias in making decisions about job categories within an OF. Also discussed are the effects of deviant scores, or "outliers", on analysis of TA data. Outliers do not fit expected patterns, can create statistical anomalies, and affect the variance of the distribution. Recommendations are given for isolating such cases and making systematic decisions about their inclusion or exclusion from analyses.

Stone, C. Harold, EVALUATION OF THE MARINE CORPS TASK ANALYSIS PROGRAM, Final Report, Technical Report No. 16

The Final Report summarizes studies in the eight Research Areas into which this project was divided. Major findings, conclusions and recommendations are reviewed. Reference is made to the fifteen technical reports that are end-products of our research, and annotations are provided for each report in the Appendix.

APPENDIX B

Study Directive

STUDY DIRECTIVE

1. TITLE: Evaluation of the Marine Corps Task Analysis Program (FY 74)

2. BACKGROUND

a. In consideration of current manpower and budgetary constraints, the Marine Corps is taking positive action which is pertinent to the vital issue of getting "the right man in the right job". The approach being pursued is encompassed within the Marine Corps Task Analysis Program which was established in October 1969. It is an interdisciplinary program designed to acquire factual data in order to define individual work actions in behavioristic terms, necessary skill attributes, and job/billet requirements. Task Analysis is providing a comprehensive review, analysis and evaluation of the work performed by Marines throughout the Marine Corps.

b. By definition, Task Analysis is the technique of identifying, collecting, collating, and analyzing job data. These data represent answers from job incumbent Marines to the following questions.

(1) What does the Marine really do?

(2) Why does he perform his job?

(3) How does he perform his job?

(4) What skill attributes and levels does he require to perform his job?

c. The methodology of identifying and collecting these functional facts is by personal observation and interview of Marines in their working environment, and subsequently through the administration of a task inventory (occupational questionnaire). Additional information is obtained from printed documents, schools, and data acquired from appropriate experts. These collected data are then collated and qualitatively processed through the IBM 360/65J, IBM 360/40H or the IBM 370/155 computer. Computerized Occupational Data Analysis Programs (CODAP) have been designed to organize the raw data into meaningful job related categories which provide realistic structuring of the responses into jobs, duties, and tasks. Analysis is then performed on the computer output and all related pertinent information and factors with a view toward improving the functional area of:

(1) Classification

(2) Assignment

(3) Training

(4) Grade structure

(5) Job requirements

(6) Job validation

Other areas which could conceivably be affected include force structure, tables of organization, tables of equipment, and logisitic support requirements.

d. Upon completion of the analysis of an Occupational Field (OF), a final report is submitted to the Chief of Staff for approval of recommendations. It should be noted that the Task Analysis Program is not a unilateral effort. The heads of all departments, divisions, and separate offices of Headquarters Marine Corps have a vital interest in this program and are a formal part of it.

e. A recapitulation of the results of the task analysis program at the end of the 1st quarter FY 74 indicates that 30% of the enlisted occupational fields (11 of 37) have been completed. These efforts resulted in 155 approved recommendations. Based upon actual and projected calculations derived from the task analysis of these eleven occupational fields (OF 01, Personnel and Administration; 14, Drafting, Surveying and Mapping; 15, Lithography; 30 Supply Administration and Operations; 32, Repair Services; 34, Auditing, Finance and Accounting; 35, Motor Transport; 60/61 Aircraft Maintenance; 62, Avionics; 65, Aviation Ordnance; and 68, Weather Service). The Marine Corps may reasonably anticipate the following benefits whenever the approved recommendations have been completely implemented:

(1) Structural changes---369 Marine billets saved.

(2) Training line savings---512 Man-years (FY 73 and beyond).

(3) Material savings---$315,000.00.

(4) Training cost savings or cost avoidance---$4,394,757.00 (FY 73 and beyond).

f. Even with the apparent good measure of success enumerated above; it is now considered appropriate that an in-depth study be conducted to evaluate the effectiveness of the Task Analysis Program within the Marine Corps. The proposed study should concentrate upon the identification and definition of improvements and refinements which could be implemented to produce an even more effective Task Analysis Program.

3. Objectives:

a. Determine actions necessary for the improvement and/or expansion of the current program including methodologies employed.

b. Determine means to expedite completion of studies without adversely affecting the end results.

c. Determine how to better interpret and utilize data amassed relative to job satisfaction (i.e. to improve the study of those elements which contribute to job satisfaction or dissatisfaction).

d. Explore the possibilities of acquiring greater benefit in the areas of classification and assignment utilizing data collected on worker characteristics.

4. Major Factors: The study should address the Task Analysis Program as it exists today with major considerations as follows:

a. Where should emphasis be placed in future months?

b. How can improvements in the program be most effectively implemented?

c. Within what time frame should a study be conducted to maintain its validity?

d. How can data concerning job satisfaction and worker characteristics be gathered most effectively and then interpreted and utilized to gain maximum validity, usage, and application.

5. Specific Guidance: Existing Marine Corps and Department of Defense directives (including those listed below) will be given due consideration, to determine their impact or relationship with the background and objectives stated herein:

a. MCO 1200.13A, Task Analysis Program

b. HQO 1200.2, Instructions for the Marine Corps Task Analysis Process

6. Coordinating Instructions

a. Study Sponsor: DC/S (Manpower)

b. Advisory Committee:

(1) DC/S (Manpower) - Chairman (Code MPU)

(2) DC/S (Requirements and Programs)

(3) DC/S (RD&S)

(4) DC/S (I&L)

(5) Dir, MC Reserve

(6) FDMC

(7) CG, MCDEC

c. Executing Agency: DC/S (Manpower) (Project office - Office of Manpower Utilization (Code MPU))

d. Participating Agencies

(1) Commercial contractor

(2) Personnel Management Development Directorate, U. S. Army Military Personnel Center, Washington, D.C.

(3) Personnel Research Division, Air Force Human Research Laboratory (AFHRL), Lackland Air Force Base, San Antonio, Texas.

(4) Naval Personnel Program Support Activity, Navy Occupational Task Analysis Program Department (NOTAP), Bolling Air Force Base, Washington, D. C.

(5) Psychological Research Branch, Planning and Evaluation Staff, Office of Personnel, USCG, Washington, D.C.

e. Security Classification Guidance: DC/S (Manpower)

f. Funding: FY 74

Internal Support	0
External Support	$75,000
TAD Costs	0
TOTAL	$75,000

7. Reporting Instructions

a. Study Plan - Due 60 days after receipt of study directive and/or award of contract.

b. Progress Reports: Oral progress reports will be scheduled by the Chairman, Study Advisory Committee as required; however these oral reports will be made at least quarterly. Oral reports may be conducted either at Sponsor's or Contractor's location.

c. Midpoint Report: A written report of midpoint progress will be submitted to the Commandant of the Marine Corps (Code MPU) four months after approval of the study plan.

d. Final Report: Draft of final report due not later than one year after award of contract. Smooth report due 30 days after Commandant of the Marine Corps decision on study.

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